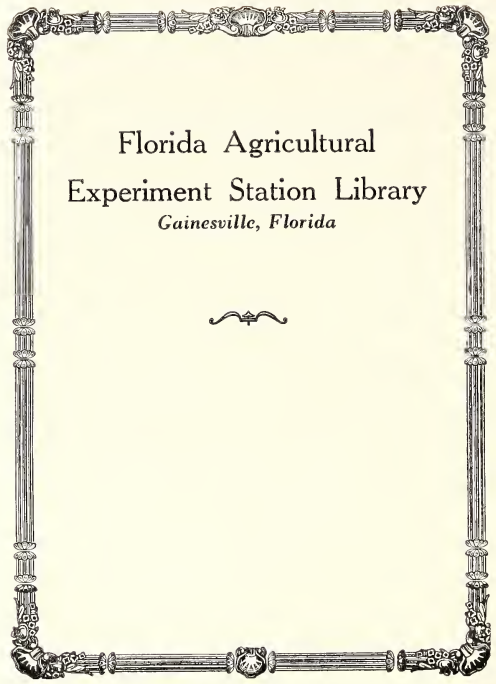
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HOW TO BE A FOREST RANGER

Careers in Conservation

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This fire-fighting parachute jumper has landed safely, thanks to his thorough training and the specially designed outfit he wears. In another minute he'll be free of the chute and the protective suit, ready to dash for the fire.

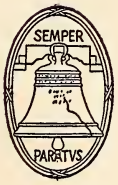
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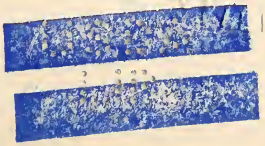
Careers in Conservation

Evelyn

By E. M. STEELE



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HOW TO BE A FOREST RANGER

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To My Family

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CONTENTS

CHAPTER		PAGE
	INTRODUCTION	9
I	TAKE A LOOK AT FORESTRY A general picture	11
II	YOUR JOB IS WAITING Jobs in forestry	25
III	KEEP 'EM GROWING Preventing forest fires	38
IV	MEN AGAINST FIRE Fighting forest fires	51
V	THE FOREST'S FIFTH COLUMN Fighting forest enemies	68
VI	"T-I-M-B-E-R!" The work of the logging engineer	78
VII	FOREST FORTUNES Reforestation	90
VIII	LET TREES DO IT! Fighting soil erosion with forestry	101
IX	BRING 'EM BACK ALIVE The forester's work with wildlife	113

CHAPTER		PAGE
X	FISH ARE FUNNY The forester's work with fish	130
XI	THE MAN AT THE TOP The work of the forest supervisor	143
XII	SCIENTISTS IN SHIRTSLEEVES The work of forestry research workers	154
XIII	FORESTS AND SMOKESTACKS Employment opportunities in private forestry	169
XIV	HERE'S YOUR DIPLOMA The education you will need	178
	APPENDIX	185

INTRODUCTION

by

EARLE H. CLAPP, *Acting Chief U. S. Forest Service*

FORESTRY looks to the future. That is one reason why a forestry career attracts many high-minded young men. Forests are a renewable resource. And forests can be made an instrument of social welfare.

Productive forests can furnish the raw material for forest industries which employ millions of workers. Forests serve in many ways. They protect watersheds, helping to prevent floods and safeguarding the water supplies of homes and communities. They harbor wild game, furnish range for livestock and provide opportunity for healthful outdoor recreation.

The forester's job is to manage the forest lands so that they will yield these products and services in perpetuity. Abundant and continuing forest resources are essential to the progress and well-being of America. But our nation has been prodigal with its forest wealth. We have come dangerously close to wrecking one of our basic natural resources. Forest depletion has been one of the contributing causes of rural poverty in many regions in the

United States. It is possible to correct the mistakes of wastefulness and destruction in the past, and manage our forests more wisely.

During the last few decades forestry and conservation have made substantial progress, but greater work still lies ahead. Sooner or later this nation must realize fully its dependence upon forests in both peace and war. Anyone who plays a part in a constructive forestry program cannot help deriving satisfaction in the thought that he is working for the good of his fellow citizens and his country. Some of the finest of today's career opportunities will be found in forestry.

CHAPTER I

TAKE A LOOK AT FORESTRY

WHEREVER the forest ranger goes and whatever he does, he is an adventurer. Bronzed with sun, his body muscular and healthy from a constant outdoor life, his green ranger's uniform blending with the green of the trees, the forest ranger presents a striking picture. He is a symbol of the dynamic work that is forestry.

He is in the army too—the army of Uncle Sam's Forest Service, the green-shirted battalions that keep and defend the mighty redwoods of the West, the fir and spruce of the Rockies, the towering Sitka spruce of Alaska, and the South's thick forests of pine. From coast to coast he is on the alert, ready to defend America's forest land from any and all enemies.

For there are enemies, and powerful ones. Some of the worst come with such stealth that the ranger does not know they are there until he sees the telltale evidence on the bark of the trees. These are the insects and fungi, the guerilla fighters.

Another enemy is one that leaps into the open and roars defiance—fire. At all times the ranger has to be

ready to engage in hand-to-hand combat with this invader. Floods can be terrible, too, after they once get started. The forest ranger tries to stop them before they start.

In time of war there is the threat of another kind of enemy—deliberate sabotage of valuable timber. The ranger must be prepared to be a fighter on the actual war front, too, when enemy planes drop flares or incendiary bombs into the midst of the trees. Wood is of vital importance at any time. In war it is more so than ever, especially when it must pinch-hit for certain metals and materials which cannot be obtained easily. The Nazis know well the value of wood. In fact, they call it *Universalrohstoff*, meaning "the material which can produce anything." One of their hopes has been to gain control of the world's forest supplies.

Whether it is war or peace, the forest ranger and his fellows have a big job to perform. It's a job they like doing. They are proud of their uniforms because they are proud of what they stand for. They glory in the achievements of the Forest Service and each ranger is determined to carry on the traditions of loyalty, progress and courage.

Who wouldn't like a job in which the whole outdoors is his office, where the air is as sweet as a cut apple, and where there are lakes glittering at your feet and a roof of branches overhead? Sometimes the ranger gallops to his post on horseback. At other times he depends on his own trusty legs. The modern guard of the forests has

wings too, so that he may fly to an emergency, and drop out of the sky with a parachute. He can drive a tractor or a ten-wheel truck. His is no rocking-chair job. It's a job for rugged men who glory in healthful outdoor work.

Whatever his destination when he sets out from his log cabin for the day's work, he has a definite plan in mind. Perhaps he's starting out to estimate the amount of wood in a particular forest area, pending its sale to a private company for logging. Perhaps he is going to supervise the digging of a firebreak, and he may take up a spade and get a few calluses on his hands. Or he may be going to have a look at what kind of a job the beavers are doing up in the mountains where those animal engineers have been taken to build helpful dams. The ranger is not afraid of work, for he enjoys his profession, a profession that has meaning for him and for every person in our country.

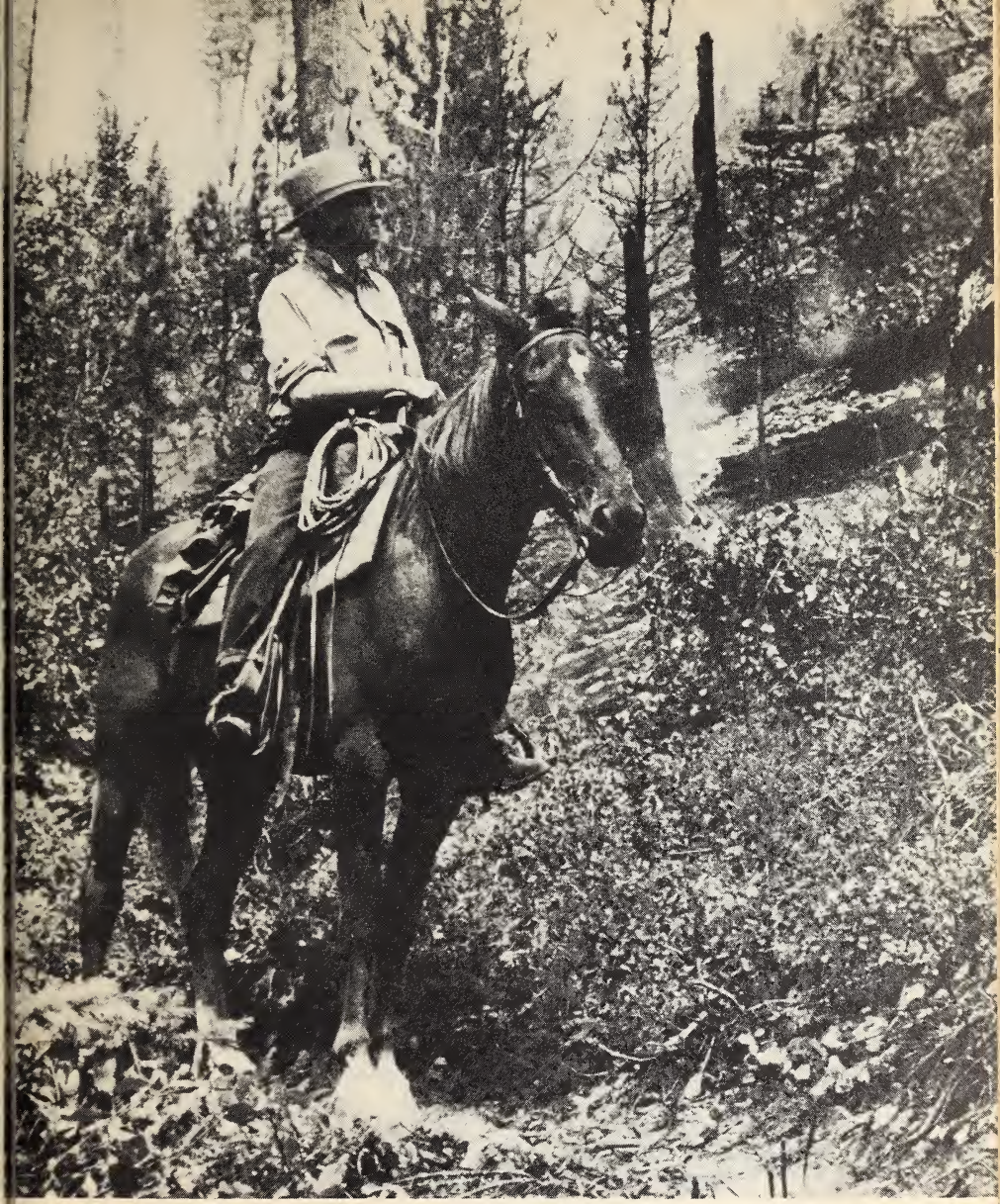
No invading insects can launch a blitzkrieg on the National or State Forest that he calls his own without having to overcome all the resistance he can muster. No forest fire can break through the green line of trees without his knowing it. Peering from the lookout tower, he can spot the blaze at its beginning, and can leap into action immediately.

First and foremost he is a friend of the forests, and therefore a friend to national defense. Cars and trucks can run on wood, gas or charcoal if they have to. Wood gives high-test alcohol, essential in the preparation of

smokeless powder and synthetic rubber. It gives heavy lubricants, cellulose, raw sugar, fibers for suits and substance that can even be moulded into planes in the form of plastic wood. Wood is used for barracks, paper, bomb crates, and as all-round substitutes for other vital materials like rubber and steel—to the extent of 20,000,000,000 feet of wood a year. This is evidence of how the army of the United States Forest Service works hand in hand with the other men in uniform.

Do you want to enlist in this force? It's not hard. You can get into some temporary line of forest work for the sake of experience, using it as a sort of kindergarten where you can find out whether a career in forestry is the career you really want. Regular U. S. Forest Service jobs require Civil Service examinations almost exclusively, but there are opportunities to get into certain branches of forestry without Civil Service and without college training or previous experience.

One way is to get a job as a forest laborer. Do you live near a State or National Forest? Get in contact with the forester in charge and see if he needs your services. That's one way. Due to the war and the necessity of recruiting more men into the ranks protecting the nation's forests, a new division of the Office of Civilian Defense has been organized which is known as the Forest Fire Fighters Service. Perhaps you will want to be one of the 150,000 civilian volunteers being sought to fight fires set acciden-



A ranger in the Kootenai National Forest, Montana, inspecting the smoldering edge of a fire that has been brought under control. His watchful eyes will see to it that it stays that way.



Rangers often travel on skis to back-country stations, towing their supplies and equipment on a sled. This cheerful trouble-shooter is hauling boxes of powder to blow out an ice jam on Big Smoky River, Sawtooth National Forest, Idaho.

tally or those set with deliberate intent by our enemies.

To be a full-fledged U. S. forest ranger you will need the proper training, just as you will need it to enter any of the many related fields. Some of these are the Soil Conservation Service; the National Park Service under the Department of the Interior; the Bureau of Entomology; the Plant Quarantine Service; or the Wildlife and Fish Bureau.

Before you decide just what branch of forestry and conservation you want to enter, you had better look at the field as a whole, its different branches and employment possibilities—and your own qualifications. To begin at the beginning, you probably want to know something about the general background of forestry practice. What is it, and why?

You have often seen pictures of the pioneers, the stalwart men in the wide-brimmed hats, a gun in one hand and an axe in the other. They helped to build up our country—but they helped cut down its timber. Some pioneers turned professional and became lumberjacks, the colorful men with calked boots and bright plaid shirts and their husky cries of "Timber!" echoing through the air. It was adventurous and brave, and the beginning of our civilization. But before the shining blades of the axes and the teeth of the saws the great virgin forests began to disappear. Still the axes and saws cut on. Their only motto was, "Get the timber out before someone else

beats you to it." They took the best trees and left the worst. By wasteful cutting methods they destroyed more wood than they removed.

There was no army of green-shirted rangers then to advise the loggers, or protect the trees. It took a couple of hundred years for people to wake up to what was happening. The evidence of the tragedy was all around them. Barren stretches of wasteland, blackened acres, areas of nothing but jagged stumps and scraggly brush.

People began to ask, "What's happening to our timber?" So in 1895 the National Academy of Science started investigating the forest situation. The government had already set aside some 20,000,000 acres of forest reserves, but that was very little compared to the total acreage of valuable timberland that was being plundered all over the nation. After its investigation, the Academy recommended to Congress the creation of a Forestry Bureau as a branch of the Department of Agriculture, and the addition of 20,000,000 acres more of federal forests. They also suggested that the government should examine public lands further with an eye to placing still more forests under federal protection.

It was a wise recommendation and a vital one, but these things were easier said than done. Private interests fought against it. They did not want government interference with their plans to make big profits at the expense of the timber. There were bitter debates and hot-headed argument.

Almost every modern nation has neglected its forests until the danger point has been reached. France did not take up forestry until most of her forests had been ruined by heavy floods and the washing away of her hillsides. China, however, had a Department of Mountain Forests nearly two thousand years ago! But this service was abandoned. The result is striking proof of the need of forestry: for centuries, China has been ravaged by floods, caused by the fact that her slopes were stripped of moisture-retaining trees.

Finally the United States got its much needed forestry organization under way. It had been helped by the action of various states. New York, Wisconsin and a few others had passed Acts for the encouragement of timber growth. Arbor Day, first celebrated in 1872 in Nebraska, had helped direct the public's mind to tree planting. A few years after that, California had established a Board of Forestry. The states took the lead and the federal government followed.

But it was not until 1905 that the Forest Service as we know it now was definitely begun. The name of the forests withdrawn from private use was changed from "Forest Reserves" to "National Forests." Two men are largely responsible for the great strides in American forestry: Theodore Roosevelt, who gave forestry the enthusiastic backing it needed to make such progressive steps between 1900 and 1910; and Gifford Pinchot, whose genius and leadership organized the Federal Forest Service. "Next to

the earth itself the forest is the most useful servant of man," said Gifford Pinchot.

Others joined in the crusade. The American Forestry Association was a pioneer among groups in this work. The American Tree Association put its shoulder to the task. Today the Society of American Foresters, an organization made up of professional foresters, has sections all over our country.

When you hear the name National Forests, just what does it bring to your mind? Huge acres of uncut timber? Massive towering rocks reflected in quiet water? Mountains crested with snow and streams as blue as the sky? A National Forest is all of these, but it is more too.

First, a National Forest is not the same as a National Park. If the government wants to release a National Forest to private ownership it can do so. Once a forest becomes a National Park, however, it cannot be turned over to private hands without a special Act of Congress.

A National Forest is a going, progressive concern. It has roads, camps, telephones and trails, and it is part of the policy of the Forest Service to supply these so that forestry and fire control are possible. The forester's main job is to see to it that there is a perpetual supply of timber. For timber is the main resource of the forest. When it is ripe, it is sold to the highest bidder and then cut and removed. In other words, the National Forests are lands owned and operated by the federal government. In them

timber is growing for the benefit of everyone, and forestry is practiced to find out just what scientific methods can do toward raising continuous crops of wood.

There are many different types of timber in the National Forests. Whether pine, birch or hemlock, to the forester it is a "crop." A farmer studying his fields wonders if he should plant rye or wheat or barley in the soil. He has to plant on the basis of what his land will produce best and what will be most profitable for his pocketbook. The forester surrounded by his green crop of trees has to make similar decisions.

It is up to him to maintain our present reputation of having the finest timber stands in the world. Take a look at our forests. The greatest in individual tree size are the famous California redwoods. Although a fraction of these giants are government-owned, the rest are in private hands and may go crashing down. Walking through groves of these monarchs you realize the beauty and power of trees and the adventure in the profession of forestry. Like green skyscrapers, they rise above you. There is scarcely any sound as you walk along the deep humus carpet formed by the needle-fall of centuries. It is like being in a mighty cathedral.

Look at a redwood stump. Perhaps there are two thousand rings of annual growth. What does that mean? It means that the tree was a tall adolescent at the time Rome fell, a lusty young sapling when the Chinese were inventing paper, a sprouting seed when Christ was born.

But in a few minutes, a whirling saw can put an end to the centuries of growth.

The redwoods are not the only great timber of the West. The largest timber in all North America, possibly in the whole world, grows on the Pacific Coast. It is made up mostly of softwoods. Next to the redwoods in size is the Douglas fir, the most important tree for timber supply.

Included in the Pacific Coast region are the forests of Alaska. A narrow coast belt of heavy timber—Sitka spruce, Western hemlock, red and yellow cedar—extends for a thousand miles along the Pacific, the dark crests seeming almost to touch the sky. In the interior of Alaska it is a different story. Except along the streams, the trees are dwarfish and of inferior species. But when the Eastern spruce which is used for paper has become exhausted, foresters think that there is enough spruce in Alaska to supply perpetually one-third of the raw material needed for paper-making in the United States.

The Northeastern forests were once the most important in our country. Now this timber region is like an oil well from which almost all the oil has been pumped out. There is scarcely any left of its two important kinds of timber, white pine and red spruce. Here is a challenge for foresters! By scientific methods they may be able to grow those important trees once more in this region.

The "old oaken bucket" probably had its origin in the Central Forest region, for there oaks are the most abun-

dant and valuable types. Aside from the oaks, there are so many other species that the Central Forest contains more different types of trees than any other region in North America. Much of the land has been cleared for farming. The important thing about the timber that remains is that it is composed chiefly of hardwoods. All the other forest areas are mainly softwoods.

The Southern Forest is the home of the yellow pine. Forestry has a future here, for in spite of blackened stretches of burnt-over land, there is no place in the United States where trees grow faster.

In the Rocky Mountain Forest, Western yellow pine, Engelman spruce, white fir and other varieties reach toward the sky and fringe the lakes. Here you are not likely to see the long, level stretches of the East. Instead, the trees often grow in clumps, like islands, at the top of hills and ridges, while below them lie bare, dry valleys and treeless lowlands. And above them tower the mountains which are too high for timber growth. Over half of this region still has virgin timber.

Just as a farmer has to understand how his grain grows, so the forester must know the habits and life-cycles of his crop of trees. He does not stick a nursery sapling just anywhere. For each locality and kind of soil, there is a species or combination of species that will grow best there. Pines flourish in sandy soil, willows near streams or in moist regions. Other trees seem to grow directly from the face of a cliff. Some trees, like dogwoods or beech, which are

often too short to get much sunlight, manage to thrive on what is left over after the taller trees above them have taken their share.

Certain trees are wanderers and you may find them on either coast, almost as far north as the Arctic Circle and as far south as regions where no snow falls. Willows and aspens are two of these gypsy types. The cypress, on the other hand, is a stay-at-home. Then there are trees which are practically useless, called "forest weeds." The forester tries to get rid of these and plant more useful ones in their place.

In some places a forest may be so crowded that the forester almost has to squeeze between the trunks. In certain forests in the Rocky Mountain States, on the other hand, the trees are so wide apart that a tractor can be driven between them. Both foresters and private owners, however, prefer the type of forest that is close-knit. When trees grow close together their lower branches are cut off from the light in early life and die. The trees grow taller and are often free of limbs for a hundred feet above the ground. The fittest survive in the forest, just as in other realms of life.

Nature is far from being a perfect forester. Her ways are often slow and clumsy. The Forest Service's green-uniformed battalion is not interfering in her plans, but helping them along. And helping Nature, the forester aids industry and agriculture at the same time. Part of his work, too, is bound up with the protection of wildlife.

Or he may spend some of his time counting sheep! Not in bed, but on the grounds of his station. If his post is in a sheep-raising district, he helps the sheep raisers count their flocks, herd them, and manage their grazing grounds. The same applies to cattle and other livestock.

Wherever the ranger's post, his living quarters will resemble this typical example: Picture a cabin set at the foot of a timbered slope, facing a big meadow. There is a river at one side, and a small creek sparkles across the yard. An attractive log fence runs around the station grounds. Inside the cabin are two good-sized rooms with running water which are decorated to the forester's own taste, whether that means pictures of his girl friend or a series of mounted deer heads. The furniture is simple and practical. In one corner is a desk for office work.

If the ranger wants social life he can jump on his horse and ride to the fire lookout six miles away where another ranger stays. Or he can hop in his car and drive into town for recreation on his hours off.

Primarily, he is a man of the outdoors, ready to ride or walk miles in any kind of weather if he has to. It's part of the ranger's code to get help through in case of emergency. Emergency or routine, there is a lot of fascinating work to do and it takes healthy, energetic young men to do it.

The forest ranger's life is not all adventure and swift action, of course. There must be solid and thorough thinking too. Since his main job is to keep a constant tim-

ber supply, he has to think and plan ahead. Although he wants to get the most timber possible, he has to be careful to leave enough of it to start another growth. When the trees are ripe and ready for harvest he sees to it that the axes and saws go into action. Otherwise, the trees will decay and eventually die without having served any purpose except to give shade to the chipmunks rambling around the trunks.

A common question not many years ago was, "Will forestry work?" The forest rangers have given their answer. Twenty years ago forestry was an experiment. Today it is a successful reality. Already a forester can show you a government tract of land that has been cut over, supervised by him and his co-workers, and is now ready to be cut again. The National Forests, one hundred and fifty of them, have not always had all the funds or workers needed—especially workers with scientific background. Even so, it has been proved that forestry is absolutely necessary for keeping our trees.

Every year, the green battalion of forest rangers grows. These young and vigorous men are the pioneers in the new tradition of forestry. Wherever stunted growth needs to be helped on its way; wherever red flames roll through the timber; wherever flashing axes are needed to blaze the trees to add their wood to lumber and paper mills, there you will find the fighting forest rangers. Perhaps you, yourself, can be one of them!



Ranger Beltz of the Homochitto National Forest in Mississippi is shown instructing the pupils of Lee School in fire prevention. This was part of the work of a contest which was started among several schools. Each school was graded according to its success in keeping fire out of the particular area designated as its responsibility.



Maps are vital to a forest ranger. Here a fire guard in a lookout tower in the Allegheny National Forest, Pennsylvania, has his finger on the approximate position of the fire. He is reporting the fire's location to the central dispatcher's office, who in turn will send a scout to the area to determine the fire's scope and how large a crew it will take to bring the flames under control.



There's plenty to see from this lookout tower in Arizona. The guard here has just sighted a plume of smoke. When he gets through with his swift calculations he will send his report to the dispatcher. He is using an Osborne fire finder, a chart with sights. By triangulation he can determine the exact position of the smoke.



An active fire at night in the Columbia National Forest, Washington. To keep such a fire in bounds, rangers and their crews may dig a long trench which the flames are not likely to cross.

CHAPTER II

YOUR JOB IS WAITING

THE sky is a glowing red. Sparks hiss upward from the blaze. A line of men in overalls is busy hacking at small brush. Others are wielding shovels. One man drives a tractor. A ranger in uniform is studying a map, while at his side another older member of the Forest Service looks over his shoulder, advising him.

Overalls or uniform, forest laborer or district ranger, all are a part of the Forest Service. It may take a bad fire to bring them all together in one spot, but whether they are miles apart or within shouting distance of each other, each worker has a definite relation to the man above and below him.

In order to manage the millions of acres of National Forest land, an efficient organization is necessary. First of all, the country has been divided into ten districts, nine in the United States and one in Alaska. The man in charge of all the National Forests within each district is a District Forester. He usually has his headquarters in the most important city in his territory. To aid him he

has experts in charge of fire protection, lumbering and grazing. The man directly responsible for the administration of each forest is a Forest Supervisor. He may live in a house within the forest or somewhere close to it. Under him are a corps of rangers, an office force, and sometimes a crew of timber experts.

All the way down the line, the Forest Service is based on a system of direct responsibility to superior officers. The forest itself is divided into ranger districts, and each one is taken care of by a District Ranger. He is responsible to the Forest Supervisor for his ranger district. The Supervisor is answerable to the District Forester for his forest, and the District Forester makes his reports directly to the Chief Forester in Washington.

The permanent force employed by the Forest Service is about 5,000 strong—and growing. About two-thirds of these are employed in the National Forests. The rest do scientific or clerical work at Washington, or research and experimental work at the Forest Products Laboratory in Wisconsin. Each year during the fire season—those hot dry months of the summer when the Service is constantly on the alert for fire—5,000 men are hired as helpers.

Now, where do you fit into the adventure of forestry? If you have had no training, you can get a taste of active service as an unskilled helper. To go much farther up the ladder you will need special training in order to pass the Civil Service examinations which are given regularly.

Today, even without any training, you have more op-

portunities of getting a taste of forestry than ever before. The need for foresters, skilled and unskilled, is at an all-time peak. The Forest Service believes that national enemies may make attempts to fire the West Coast forests, and it has worked out comprehensive plans for fire prevention and fire suppression in these and other vital forest areas.

David P. Godwin, national co-ordinator of the newly created Forest Fire Fighter Service, has appointed twenty state co-ordinators. In most cases these are foresters or other forest protection officials, and they will have the job of appointing local co-ordinators and supervising the organization and training of local units.

If you volunteer for the F.F.F.S., you will be given a twelve-hour training course in scientific fire-control methods and be placed in a regular crew or squad under a designated leader. In some states, depending on state labor laws, boys as young as seventeen are being enrolled. There is no top age limit, but you must be physically fit. In places where fire-protection agencies pay pick-up fire fighters for their work, you will receive the regular rate of compensation for actual fire-fighting duty, but not for training. If you live in the South you will probably serve without pay. Even so, you will be getting valuable experience that later may lead to a permanent job in forestry.

During the summer of 1942, in the northwestern Rocky Mountain area, the Forest Service recruited about two hundred college students as an experiment. They re-

ceived two weeks of intensive fire-control training in a large camp. Then they were sent out as fire-suppression crews, in groups of from five to ten men, each directed by an experienced leader. In one fire emergency, about fifty of the college youths were flown a hundred and fifty miles from their bases into the back country to put out a blaze that could not be reached by other means. The Service plans to expand this college program and this may be your chance to get into forestry even though you may not have completed your training.

Another very important activity of the F.F.F.S. is its work in co-operation with the Army in the aircraft-warning service. The most strategic of the 3,700 state and federal lookout towers and 3,500 radio stations of the federal service have been made available to the fighter command of the Air Forces for spotting hostile planes. Instead of being manned only during the fire season in the fall, the lookout towers have been put on a twenty-four-hour basis throughout the twelve months of the year. The personnel for this work of plane spotting is selected by the Forest Service, subject to the Air Forces' specifications. In general, it is operated by the Forest Service in both state and federal towers rather than by the Air Forces. Here is an opportunity for you to know what it feels like to be a forest lookout, and also a chance to perform a vital service in your nation's defense.

To get a better picture of the Forest Service as a whole, let's start at the bottom of the ladder and work up.

Forest Laborer (Unskilled)

This is the bottom rung. Perhaps you've seen men at work under the supervision of a forest ranger, digging the earth in a long line along the edge of a smoking forest, a perspiring crew with shovels and axes. They are strong men and well up to the physical labor involved in such work as this, or in constructing a road, damming a stream or raking up brush. They are the men who use their muscles to help the ranger build up the forest, temporary hands selected from the residents within or near the National Forest.

Here is one way to get in the Service and find out just what goes on behind the scenes in forestry. You can make an application for work at your local branch of the United States Employment Service. Or, if there is a forest supervisor or district ranger near by, you can apply directly to him. All you need for this job is the energy and desire to work. Your wages will vary, depending on the local rate paid for unskilled labor.

Forest Laborer (Skilled)

Do you know how to make a bulldozer go through its paces? How are you as a mechanic? Are you handy with a hammer and saw? In other words, are you a skilled laborer, such as a mason, a machine operator or a me-

chanic? If you are, you have a good chance to get into the Service. Watch the bulletin board of your post office or public library, or wherever notices of Civil Service examinations are posted. If you pass the examination you will have taken the first step to being hired.

Forest Guard

It might be more correct to call this man a "fire guard," for most of his work is in connection with forest fires. He may carry a tank of chemical extinguisher on his back, scratch chalk marks on trees which are to be sold, or check the number of cattle or sheep entering and leaving the forest. He may work on the construction of buildings or take care of a warehouse. The forest guard is a Jack-of-all-trades, doing whatever his superior officer tells him to do. His work lasts only about three or four months out of the year, but it's exciting work while it goes on.

Watch the bulletin boards for this job too, since it requires a Civil Service examination or Civil Service "excepted" appointments. You will find it posted annually prior to the opening of the summer field season. If you like camping, that's fine, because you may get a chance to do a lot of it, along with hiking over every kind of interesting terrain with a pack on your back. In this division, as well as in others, neatness, sobriety and ambition will take you far.

Junior Range Conservationist

On the range cattle are dying from drought. A strange plant disease is destroying the natural food for livestock. Improper drainage on several farm sites is polluting the water source.

It is the challenge of such emergencies that the Junior Range Conservationist meets. He is an assistant to the District Ranger, and makes surveys of ranges or does other forest-range work for which qualified men in the organization are not available.

This job is only for men between twenty-one and thirty-five. If your age qualifies you to apply, you must be able to show that you have had the necessary background and training, which means a degree from a college or university of recognized standing, showing that you have had at least one year's work in plant physiology, systematic and economic range botany and plant ecology combined. If you have not had these courses you must show that you have had their equivalent, at least, either in past experience or special training. The examination is given annually.

Junior Ranger

This title means what it says. You're a regular forest ranger, but in the junior class with less pay, of course, and less responsibility. You should not be under twenty-one or over thirty-five. In other words, you have to be young

and hardy to do the vigorous job of protecting the forest from its age-old enemies. Fire control work, timber cruising and supervision of cutting, assisting in recreation and the construction of camp sites in the National Parks, call for men of action.

Associate Range Conservationist—Assistant Range Conservationist

At this stage you no longer need to watch the bulletin board, for these two types of worker get their jobs by promotion from the ranks of assistants and junior range conservationists.

Here your duties require knowledge and experience in dealing with range problems and livestock grazing, together with supervising forest-range investigations and administration.

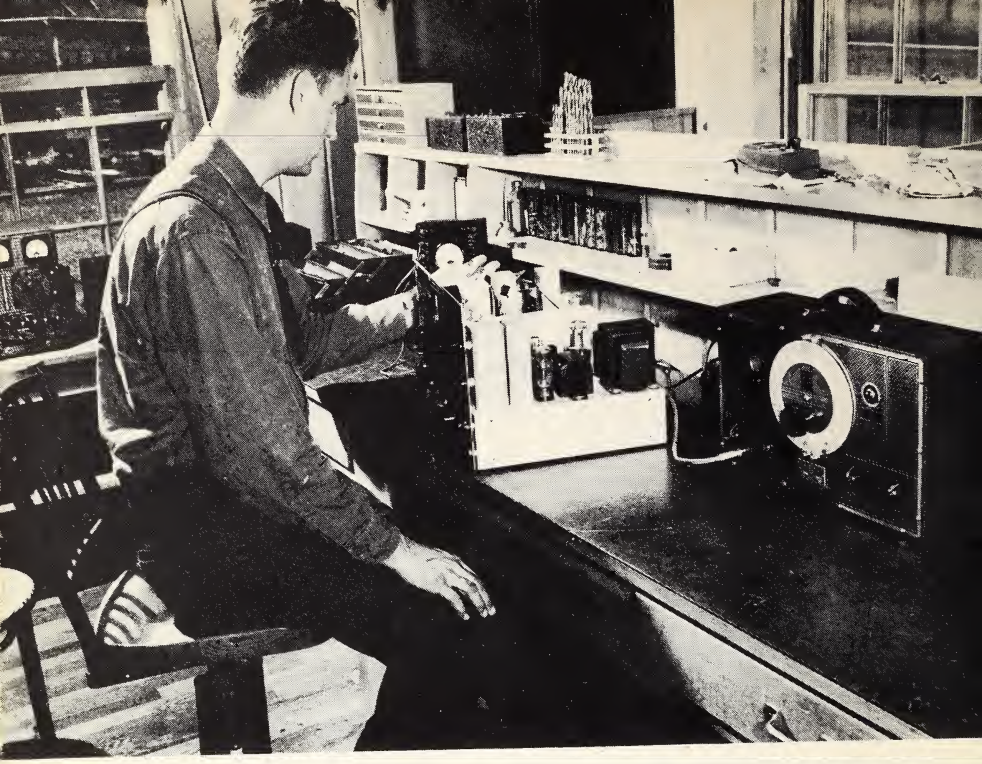
Logging Engineer—Chief Lumberman

Lumberjacks with the bright plaid shirts and their cries of "Timber!" have a place in the National Forests too, for every year they come to log out timber which has been sold to their private employers. You can be sure they do not hack away at the trees just any haphazard way. Not with the Logging Engineer and the Chief Lumberman around.

The former is a super lumberjack, though he does not



Yes—they're setting a fire, but there's no danger. Modern backfiring is a science. By burning a wide strip free of "fuel"—any burnable material like dead trees, brush and other vegetation—the fire is stopped because there is no fresh material to feed the flames.



This Forest Service technician is repairing and testing one of the transmitters used at the station. Because of the continual use of equipment during the fire season, radio sets must be carefully watched and kept in good repair.



Here a ranger in the field is using a midget radio to contact headquarters in order to receive instructions or ask for more men or equipment. Radios like this have cut fire-reporting time in half. The ultra-high frequency radios can be used when lightning is flashing all around.



Above: Photo taken by a flying ranger whose job it was to find out facts about the fire in order to guide the fire fighters.

Below: These unskilled laborers are being trained during the fire season so that they will know what to do when they are called to emergency duty.



handle an axe or bucksaw. He is an official with expert knowledge and experience in logging engineering, lumber market and prices, and all the other technical features of the lumber industry. He makes the plans for the most effective disposition of the timber by sales. Also, he makes stumpage appraisals (estimates of the value of a wooded area) for large transactions.

The chief lumberman helps local forest officers in conducting timber sales, and reports on tracts of timber where a sale has been applied for or is advisable. In order to do a good job of this, he must have had thorough training in cruising (estimating timber worth), logging, scaling (measuring timber), and the processes involved in sawmills.

Here again, positions are filled by the promotion of men in the Service who are fitted for such work. In case there are no such men available in the organization, competitive examinations are held.

Associate Forester—Assistant Forester

Maps and statistics are on the desks of these two technical employees. What is the report on the latest survey of Willamette National Forest? Quickly the secretary brings it in to the Associate Forester or the Assistant Forester. Do we need new trees planted in Superior National Forest? How many acres of Sitka spruce can we sell this year? These and many similar questions must be

answered by these foresters. They act as technical advisers to the forest supervisors on matters of purchasing timber, measuring it, mapping out forest areas and boundaries, arranging for nursery work and planting. They handle the available timber resources and plan for the development and growing of new crops.

Vacancies in the associate forester's position are filled mainly by promotion of assistant foresters who have made good; while vacancies in the assistant forester's position are filled by junior foresters qualified for advancement.

Forest Ranger

The forest ranger is the man who is everywhere and anywhere—fighting on the fire line, helping loggers cut down a forest, or keeping an eagle eye on the timber from a lookout tower. He is seldom idle. Having from 50,000 to 400,000 acres of forest land in his charge is a demanding job, but a thrilling one.

If you are already in the Service and have done a good job as a junior range conservationist or a junior forester, you are on your way to being a forest ranger.

You will never have to complain about monotony in your work, for it is as variable as the weather. It depends on the location and the resources of the forest. Fire control, timber management, supervision of grazing and livestock, assistance in the protection of wildlife and fish, supervision of recreation and construction of camps and

other structures—all these and more will need your attention.

Of course you will have an assistant in all this work, for a forest ranger is not expected to be a superman. You will have to have good personality traits and a clean character, along with certain physical qualifications of health and strength. You will spend a good deal of time away from home if you become a ranger, for you will have to do a lot of traveling over your district.

Assistant Forest Supervisor

The assistant Forest Supervisor, like the ranger, has little time to sit in an easy chair and dream. He helps the forest supervisor in the administration of the National Forest. How much authority he has in this work depends on what his superior officer gives him.

To get this job, you must first have been an assistant forester or forest ranger.

Forest Supervisor

The Forest Supervisor sits at his desk in a busy office. Memoranda, notebooks, letters and financial statements lie upon his desk. His secretary is at his elbow. The phone rings. A white-coated research scientist comes in for instructions.

Yes, he is a busy man, for he is the manager of all the

jobs and activities of the Service. It is up to him to see to it that the forest is a going concern which is not running into the red. Good judgment, clear thinking, experience and wide technical knowledge must be his—experience and knowledge learned on his way up the ladder. For this is the top rung. Perhaps you will be one of those who reach it.

When you are thinking of forestry as a career, you should not forget the work being done by the United States Forest Service in cooperation with the states. There are now more than forty states employing foresters in various capacities. The state forester has a challenging and inspiring job. He has a real chance to do pioneer work in those states where forestry is still pretty much in its infancy. Mainly, he has to develop a sound forest policy and educate the people to take care of the forests they have. This calls for speaking before the public and meeting a wide variety of people.

If the state already has a settled forest policy, the state forester supervises the carrying out of orders.

Another very important field of employment is that in private forestry. Privately owned timberlands make up two-thirds of the forests of our nation and produce about 97 per cent of our lumber and forest products. They represent an investment of about ten billions of dollars and give employment to over a million people. More and more of these private companies are hiring trained foresters.

Teaching, too, offers opportunities to the technical forester. The field is small, but growing, and there are numerous calls for men with practical woods experience and ability as teachers.

Salaries vary in state and private employment. Those in the federal service are generally stable and approximate the following:

Forest Guard	$1200 or $2000
Junior Range Conservationist	2000
Junior Forester	2000
Forest Ranger	2000
Assistant Range Conservationist	2600
Assistant Forester	3200
Chief Lumberman	3200
Logging Engineer	3800 or 4600
Assistant Forest Supervisor	3200
Forest Supervisor	3800 or 4600

Whatever way you look at it, forestry is a wide-open field. Competition is keen, but you will enjoy meeting the challenges. Forestry wants and needs men with ambition, resourcefulness and perseverance. You are helping your country and yourself when you wear the uniform of a forest ranger.

CHAPTER III

KEEP 'EM GROWING

THREE THOUSAND PEOPLE BURNED TO DEATH IN FOREST FIRES!

THREE MILLION ACRES DESTROYED BY BLAZE!

WHOLE TOWN BURNED TO THE GROUND!

YOU won't be seeing forest-fire headlines like these in your daily paper—not if the Forest Service can help it! Today the forest rangers are on the job to keep such statements from ever being true again. When a fire does break out, the ranger drops everything and goes to it. His face is probably grim as he sets out, for the blaze means that all his efforts in prevention have been in vain. The chances are that the fire started through no fault of his own, but was caused by a careless smoker or camper, or perhaps by some purely accidental force like lightning.

With unflagging vigilance, the ranger takes every precaution to keep fire out of his forest. He does a good deal more than preach theories to the public. He rolls up his sleeves and tackles the job of prevention himself, using every means there is to eliminate the hazard of fire. This

work of defending the timber from its deadly enemy is called *presuppression.*

There are probably no men in the various forces employed by Uncle Sam who are more loyal to their branch of the service than the foresters. State foresters are of the same high caliber. With increasing numbers of Americans coming to the forests on vacations, sporting trips, and sight-seeing tours, the rangers' work has been doubled and the danger of fire has been greater. If the public had to line up on the fire lines and battle the flames, perhaps the rangers would not have to see their careful precautionary work undone so many times. Education of the public alone, however, will not do the job. Not only are fires caused by people who toss cigarette butts into dry piles of leaves or go away from merrily burning campfires, but they are brought to the forest in other ways as well.

The glowing sparks that belch out from the stack of the locomotive as it thunders down the rails at night may be a colorful sight, but to the forester it means only one thing—trouble! One of those tiny sparks may make a crimson torch of a nearby tree and the torch will be passed on in a relay race from tree to tree.

The train can be a villain in other ways too. Coals dropped or blown from faulty ashpans, the burning of old ties, the fires set to clear the right of way—these also are on the ranger's mind as he watches and hears the trains clack by.

What can the forester do? Obviously he can't just go

to the owner of the railroad company and say, "See here, you'll have to tear up your rails and take your engines some place else." In the first place, no efficient forester goes about looking for extra trouble for the Service. He does his best to be diplomatic whenever he has to deal with the public. In the second place, there is a definite procedure that he can follow to protect his timber from a dangerous train.

What he does is to report the guilty engine for inspection, with a recommendation for repair of the parts causing the danger. It is possible, of course, that the forester may still have to see the head of the company personally in case the latter insists that his train can run in any condition he sees fit. The forester's first weapon is persuasion and reasonable argument. If that fails, he will usually have the legal power, backed by the authority of the state or federal government, to make the owner come to terms. He can order that the locomotive be removed from service until it is made safe. On the inspection report ordering the locomotive off the tracks he will list the reasons for its removal and what should be done to redeem it. As nearly all locomotives now have spark arresters, the forester has an easier time of it.

Another presuppression measure in connection with railroads is the construction of firebreaks. Look at a railroad and you will see that there is often a good deal of brush or vegetation along the edge of the tracks. Beyond the vegetation may be valuable forest land. The brush

acts as a perfect conductor of flames to the bases of the trees and the forest floor in case a stray spark or live coal lands on the bordering strip. When you see crews busy plowing the strip and cleaning all the waste and debris away you can be sure that the owner of the railroad has had a visit from one of the men in green.

Instead of the sound of birds, the roar of trucks and steam shovels may echo through the National Forest. A new highway is going through and, as always, the forester is on the job. In the distance some of the crew are burning stumps, and near by a dump fire is glowing brightly.

The forester goes up to the foreman in charge. "May I see your permit, please?"

In most cases the foreman will be able to show the forest ranger a paper called a "permit to burn." Such a permit means that the administrators of the highway building job have agreed to abide by all the regulations of fire control and hold themselves responsible in case any damage results.

Since the National Forests are sources of timber, logging operations take place among the tall trees. All sorts of engines may be used in the job of felling and removing the trees, and a number of these engines may burn coal or wood. Here again, ashes and coals can start the process which changes a living forest into a dead and blackened wasteland.

"Better clear all that debris away from the donkey-engine over there," the forester suggests to the foreman.

"You will have to take safety precautions, too, on all the wooden bridges you put up. And don't forget the smoking and burning rules."

No forester who wants the cooperation of private workers in his timber makes such requests with a "bossy" attitude. Courtesy, as well as loyalty, is a part of the forester's code. He wants the public to respect the uniform of the Forest Service at all times and he strives to make it worthy of that respect.

He does not consider such tasks of instruction minor matters. A match is a minor thing, but a small flame from just one match can mean hours of fire fighting for him and his fellow workers. He has seen at close range the terrible enemy at work and knows the awful devastation it can bring. He knows that, in spite of everything, 50,000 fires still sweep across our forests every year, burning an average of twelve million acres. Each fire leaves the country a little poorer. In the Northwest and the northern Rockies most of all, great tempests of flame rage over vast areas, killing everything in their path, drying out the soil and shriveling up the seeds in it.

The big fires make the headlines, but they are not the only destructive ones. Light fires that run along the ground, just scorching the bark of trees, injure not only the trees of today but often kill the trees of tomorrow. The big trees have some protection because of their thick bark, but the small ones, the saplings just getting their start in life, go down before even a mild blaze.

Even if the big trees are not killed by a light fire, they are greatly weakened. Under the best of conditions, trees have to put up a heroic fight to survive. A fire can turn the tide against them by opening the way for their other enemies to creep in. Fire often acts like a tank division breaking the way for the light artillery. It opens up wounds and scars in the bark, making perfect entrances for insects to carry on the work of destruction. Fungus, too, enters the fire wounds to bring disease and decay.

The forester knows that fire breeds fire. Each batch of flames leaves the timber in a better burning condition for the next onslaught. The soil as well eventually becomes worthless. Adirondack fires have burned trees, leaf litter and soil down to bare rock in different sections. In the West a constant battle goes on every year between dry brush and forest. If fires destroy the young forest it is not hard to predict which will win out.

There are three distinct types of forest fires. The kind that runs along the ground and is known as a *surface fire* is the most common.

More vicious and destructive is the *crown fire*. Such a fire is caused by strong winds whipping the flames of a surface fire into the tops of the trees. The flames are hard to fight because they can leap across great gaps and spread swiftly. The crown fire causes the greatest loss of human life. Sometimes in the Western States such fires burn until the smoke darkens the sky as far east as the Atlantic Coast.

The third type is the *ground fire*. This burns underneath the ground in peat beds or where there has been a spongy accumulation of leaves and twigs. The worst feature of such a fire is that it may break out and develop into one of the other two types.

It is no wonder then that the Forest Service puts presuppression at the head of the list of its duties. In some aspects of this job the ranger resembles a general assembling his forces and planning his strategy for an expected battle. At any moment a blue spiral of smoke may curl up from the hills like an enemy banner calling him and the rest of the army in green into action. At any hour of the day or night he must be ready to forsake the defensive rôle for one of offense and active combat against the enemy.

You have seen pictures of the tiny cabins high on mountain peaks, or the tall towers that keep a constant vigil over the forests. Here, on twenty-four-hour duty, sits the forest lookout. If it is a rainy day he goes down the mountainside to pack in new supplies. If there is no rain the supplies are brought to him, for he cannot leave his post in dry weather. Day after day, in every direction, his keen eyes watch the country round about.

When he is not busy watching, he is making charts. The charts show just how great or small the danger of fire is at the moment. He tabulates reports from the nearest weather bureau on a special slide rule and transfers these numerically to the fire-danger board three times a day. At

the top of the board he puts the number which represents the current fire hazard. For example, number one indicates no danger, high humidity, green woods, a calm wind and unlimited visibility. Number seven, at the other end of the scale, means extreme danger.

Humidity is the factor the lookout especially keeps check on. When the air is moist and the timber wet, there is less fire danger. His instruments tell him exactly what he wants to know—and sometimes what he does not want to know.

What happens when he suddenly sights an ugly dark plume of smoke on the horizon? Among his instruments the lookout has an Osborne fire-finder—a chart with sights by which, with triangulation, he can locate the exact position of the column of smoke. He sees the smoke, lines it up on his chart, and then contacts the forest ranger's station by either radio or phone. Sometimes he uses a heliograph, an instrument for sending messages in code by the use of mirror flashes. With the advent of radio, this method is now less used.

But the lookout is not satisfied with knowing only the location of the fire. He must know the type of wood growing at the site. For instance, if the trees in that section are redwoods it means that the fire fighters should be able to put the flames out in short order. Redwoods have a thick, coarse bark that is resistant to fire. But if the area is full of birch, it is a different story. Birch trees are quickly scorched and burned.

Down on the ground, the forest ranger, the dispatcher and all the rest of the forest officers on duty assemble themselves for work. Time is important. This is the moment the forest ranger has prepared for carefully and thoroughly. The men and the trucks are ready. The roads are in good condition. The equipment is in shape and on hand. If the fire warrants it, outside help will be enlisted, semiskilled and unskilled labor in the vicinity.

The first line of personnel upon whom the forester will call are individuals stationed at primary or secondary lookouts such as logging camps. These wardens must be ready to ride or run to the fire. Included in the forester's first-line fighters, too, are special small crews serving as a kind of stationary patrol at central points and equipped with fast motor equipment in case they have to reach a specified area in a hurry.

The second line is made up of men employed on near-by railroad crews or in logging, or other kinds of labor groups. The forester sees to it that the men are supplied with the necessary tools and equipment and makes arrangements for their transportation to the fighting area, by truck or train.

His third line consists of persons still farther away from the immediate vicinity of the fire. Only when he cannot cope with the burning timber does he call in these reserves, for he has to consider such technical details as the equipping, feeding and supervision of the unskilled crew. The forester is in the position of an army

captain or general who does not want to exhaust his reserves if he can accomplish his ends with more economy. In emergencies the forester has the right to draft workers at four dollars a day.

What about the time factor in reaching the fire? Let us suppose that a fire has just been reported. The forester is contacting his helpers. The trucks begin to thunder down the roads. They reach the blaze and the forester calculates just how big the fire is and how long it is going to take him and his men to put it out. The flames can reach a certain point without his having to feel that he has failed in his prevention or control measures. The amount of timber that can burn on any given area and yet remain within certain standards has been figured out scientifically.

If the fire confronting the forester is the first of the year on that particular area and he gets it under control quickly, it means that he has not exceeded the money and time allotted him in the previous estimates of cost and control on the particular land. Scientific estimates on a specific tract may state that fire may consume one per cent of its total area per year. In the forester's language this is called the amount of "allowable burn." He tries, of course, not to have any fire at all, but if fires do occur in spite of all his presuppression measures, his next step is to try to put them out according to the prearranged standards.

Time wasted in getting to a fire has been cut down

enormously by the use of radio. In the past, a dispatcher might send only a couple of men to a fire, thinking that it was a minor blaze. On arriving at their destination, the two fire fighters often found the fire far beyond their scope and had to race back ten miles or more to get help and equipment. By the time a bigger crew returned, the fire could have spread beyond control.

Now when a smoke chaser strikes out to see how much of a fire the Service has on its hands, he carries a complete radio outfit with him, the whole thing weighing only eight pounds. When he arrives at the blaze he tosses a few feet of antenna up over the branch of a tree, hooks up his set and starts telling the ranger just what the situation is. Five minutes later, the necessary men and equipment are on their way.

The midget radio has cut fire-reporting time in two. It owes its existence to Gael Simson, the radio genius in the Forest Service. It transmits and receives and has a range of twenty miles even in the roughest surroundings.

The telephone communications in the National Forests are also an intricate maze of efficiency. Sometimes in electric storms, however, the phones will not work. That's when radio comes to the rescue. The ultra-high frequency radios can be used even during a severe thunder storm.

Measures of prevention and control are constantly being improved. The forester with imagination and the ability to apply his theories in practice is a welcome



Above: Fires against the night sky—but they're friendly fires set purposely to block a larger fire which is the real enemy. A back-fire such as this creates a burned-over strip which stops the larger fire from advancing further.

Below: Another test-tube fire set by the rangers in a safe area to study its actions on a typical piece of terrain.





This strange contraption measures weather conditions. The fire guard is placing basswood moisture-content strips on the scales. These strips will tell him the humidity of the air and warn him when the air is dry and conducive to fire, or heavy with moisture and less likely to cooperate with forest flames.



Tea Kettle Mountain in Montana, but that's not steam. Where there's smoke like that there is fire, and where there's fire you'll find the rangers ready to fight it with the most ingenious of modern weapons—plus the loyalty and teamwork that make the Forest Service.



Above: What the well-dressed smoke jumper will wear. The kit includes suit, gloves, emergency and regular chutes, rope, utensils and a two-way radio.

Below: The airplane is a recent arrival in the employ of the Forest Service. The supplies being loaded here will be flown in above difficult terrain and dropped to the men fighting a fire.





Above: The hatch of the plane is stored with food, clothes and tools for the fire fighters on the ground. Even eggs can be dropped by packing them between loaves of bread. Burlap parachutes, like the one you see rolled above the crate, are attached to each package.

Below: This forest ranger is one of the men who has volunteered for training in the art of smoke-jumping. He is ready to leap.





Maybe you've always thought of the ranger as a man on horseback. He is, but he also has desk work to do. And when he does it you'll find him in an office such as this one at Taos, New Mexico.

member in the green battalion. Ed Haff and Leonard Beltz are typical of the progressive spirit of the rangers. Believing that one of the best prevention measures is education and more education of the public, they figured out a way to make such education both popular and useful in southwest Mississippi.

Haff and Beltz decided that the slogan, "Competition is the life of trade," might well be changed to "Competition is the life of conservation." As a result, they started a fire-prevention contest among the twenty-two grammar schools near the Homochitto National Forest.

The students looked forward each month to the visits of the foresters. In each school was hung a map of the forest, with a definite area outlined and specified as the one which the particular school was responsible for keeping free of fire. "The ranger is coming today," was the familiar whisper through the schoolroom. When he arrived, they watched eagerly while the man in green stuck red pins in the locations where fires had occurred. It was a blow when one of those red pins went on their own area. The contest ran for six months and prizes were awarded to the schools having the least number of fires in their areas. The result was a substantial reduction in forest fires in that vicinity.

This is only a small sample of what the forester can do in inventing new ways to bring the public around to his side of the battle. The records show that our country has an average of one forest fire every three minutes, and

the battle is to reduce this record. Education of the public and preventive measures of other kinds make up the ranger's first line of defense. But when that line is broken and the red scourge of fire breaks through, then he must be ready for his next big struggle—the attack and defeat of the fire itself.

CHAPTER IV

MEN AGAINST FIRE

"CALLING all rangers! Calling all rangers! Fire in the National Forest!"

The men in green have been waiting for that cry. For days they have watched the hot sun bake the earth and turn the leaf mold and needles to tinder. In the steel towers, the lookouts have sat behind their glass walls with watchful eyes. The forest supervisor has checked and rechecked the maps, weather reports, and fire plans on his desk. The chief fire dispatcher has checked the primary outposts. Stand-by crews have been held in readiness.

And now the moment has come. Put yourself in the forester's place as he faces the blaze. The flames hiss through the air. The smoke darkens the sky and smarts your eyes. Time is precious, but you must wait until you have analyzed the situation correctly and have decided on scientific lines of approach. For there can be no blundering against this enemy. Not only are rich acres of forest land at stake, but human lives as well. You cannot send your crews against the fire simply on a hunch that

you are directing them in the best way. If they are trapped and ringed by the flaming mass it will take more than a hunch to get them out again.

Think! Where is the head of the fire and in what direction is it moving? What most valuable timber needs protection? Where is the fire likely to burn itself out first? What natural obstacles such as lakes or rivers can you count on to come to your aid? Where is the best place to station your men in respect to efficiency and their own safety? This is no small grass fire which you can beat out with a wet sack. No, this is a broad front of fire moving like a red scythe over the valleys and hills, a destroyer that must be stopped!

You are ready for action. Your crews and equipment are only waiting for the command. You spot a small, light area of fire apart from the main body.

"Make a line—on this side of the flames!" you order.

The men armed with such simple tools as shovels and axes go to work. They are your infantry. Now they take their positions and start the job. The soles of their shoes smoke as they tramp along the smoldering edge of the fire. Some are breaking the ground with their shovels. Others have hoes and rakes with which they scrape and push debris away from the flames and shove dirt onto the fire. A few men are armed with "spankers," a tool made of a wide, flat piece of belting on a strong handle. Small sparks fly up as they beat the flames. The crew is working at the foremost edge of the fire, using the direct

method, the method used whenever it is possible to work so near the flames, as in light fires.

To your right the flames are more intense. You cannot send men too close to them. So you order the crew to use the close-in attack. That means that instead of marching to the fire's edge like the other workers, they draw back about two or three feet ahead of the advancing edge. Swiftly, they begin raking a line there. The fire is permitted to burn up to the line.

But what if even this approach is impossible, due to the intense heat and threatening swiftness of the blaze? You will have to fall back anywhere from ten to fifty feet to create your fighting line. This is called the parallel method, a way often used with weak crown fires.

What if even fifty feet is too close? Then you and your men will be forced to fall back for a safe distance to a ridge or a stream or a rockslide or whatever natural obstacle presents itself. There the crews once more construct a line, usually by digging a ditch or raking the ground clear of debris so that there is a connecting firebreak between two or more natural obstacles like streams, plowed fields, or rockslides. Then they proceed to backfire the area between the line and the approaching flames. This is the indirect method.

These are the basic hand methods of fire fighting. The use of water to quench flames is, of course, a common strategy. However, before modern equipment made it possible in most cases, water was not always so easy

to obtain. Transportation was the big difficulty. A bucket brigade could scarcely cope with giant fires. Today, the forester can usually wear a one-man outfit which includes a back-pack tank and trombone pump. This is an efficient instrument for "mop-up" work and backfiring operations and has prevented the breakaway of hundreds of fires.

Another means of getting water to the conflagration is by trucks, generally called tankers. These can get to the scene quickly and do very effective work. Their one drawback is that they are usually confined to roads. Where the terrain is roadless, or too rough to permit trucks, tractors come to the rescue. These tractors, completely equipped with tank, pump and hose reel, are a comparatively recent development, and are still under test. In the same category is a machine mounted on a truck, which uses dry ice as a pressure medium and throws a stream of water without the need of a pump. On the whole, portable power pumps using an inch-and-a-half hose have been made very efficient, with the result that a strong stream of water can be transported thousands of feet even in rugged country.

Trucks haul more than water. Their first service is the transportation of men, pack mules or horses, and small equipment. They are also used to carry heavy power units like tractors and plows.

Since the work of creating control lines is the backbone of fire fighting, foresters and engineers have tried

to figure out more efficient ways to do the job than the old shovel methods. A result of their efforts is the Bosworth trencher. Watch one of these at work and you are hard put to it to decide whether it is a cultivator or a rotary snowplow. As it ranges along a side hill it digs, claws and tosses everything out of its path. Actually, it has the general construction of a wheelbarrow; there are two handles behind and a wheel in front. The engine is fed by gasoline and develops from five to nine horsepower. The engine is mounted in the center. By means of driving a drum of small, whirling hammers which strike the ground, the machine carves out a shallow trench approximately fourteen inches wide. The trencher's big asset is its swiftness. Also, it is so small and light that it has a chance to arrive at the fire with the first men, something which is not true of heavier units. Furthermore, it can be used on steeper slopes than the horse and plow or the tractor.

Every year foresters devise more modern means of licking their worst enemy. One experiment was performed with a strange-looking contraption called a wind machine. A rumbling tractor in front of the machine pulled it forward and to the edge of the fire. Suddenly there was a roaring gush of air. The old-timers looking on, stared and scratched their heads and wondered if a hurricane had swept upon them. The uproar was caused by the strange new machine, which, when it was set in motion, developed a forty-mile gale. The watchers

had to admit that it looked like a pretty good idea, for the strong blast of air forced the flames back and permitted men to get close enough to the blaze to do more effective work along the trenches.

The foresters are trying out power-driven saws that can be clamped onto a big snag—a dead but still standing tree—and will eat it through in short order. For, even though a good line has been laid, snags still create danger spots. Fire may run up a snag to the very top and the wind can carry bits of the smoldering wood for some distance to start new fires beyond the lines. The usual method is the use of the old familiar axes and saws. But if there is a better way to do a thing, leave it to the foresters to find it out.

One of them not long ago filled an old inner tube with stumping powder. He tied it around a big fir snag, like a noose. Next he stuck in a cap and fuse. After it was touched off only a short stump was left, too low to spread fire. Other foresters have obtained the same results by boring holes in snags, tamping them with powder and blowing them up.

Another modern device that the forester can use is the new Stewart well-digger, invented by Gilbert Stewart of the Michigan Department of Conservation. It can go wherever the forester goes and produce water in fast tempo. The device is installed on a light truck in which there are a pump, a tank of water and a small derrick.

The foresters drive to a spot within hose distance of the blaze.

"All out, fellows!" one of them calls.

The next instant they are busy setting up the derrick.

"Hot work," one forester says with a grin. "But wait until we get the water pouring out. And it won't be long!"

It isn't long. The water is released from the tank by hydraulic pressure. The derrick drives a casing down into the ground until water is struck. In the Great Lake States this may be from eight to ten feet below the ground. Once the water is found, the foresters push a hose end down through the casing, and that's the beginning of the end for the near-by flames.

Even more spectacular methods of defeating forest fires are being worked out. One of the most ingenious, even though it is not entirely practicable yet, is the use of a pipe to run along a fire trail. It is no ordinary pipe, for at regular intervals there are wax-capped valves. When the flames get near the wax melts—then, like a series of small geysers, streams of chemical "fog" are released, smothering all the fire in the vicinity.

It takes brave, determined men to face walls of flame, who won't cry quits until the last spark is out, whether they are fighting from ground positions on the lines and fire trails, or whether they're carrying on the battle of the Forest Service from the air.

For the modern forest ranger has taken to the air. His wings are young yet, but they're growing. Eventually, even all the ingenious devices for ground work in the conquest of timber fires may become only the auxiliary weapons of the airplane.

Here's an example of one way in which the flying rangers work. In August, 1938, a forest fire broke out near the summit of the Wallowa Range, 6,000 feet above sea level. One look at that fire and the foresters knew it wasn't going to be an easy matter to control, even though 400 men and 50 horses with equipment were there and ready to do their best. It would take days to lick the flames. In the meantime, what were they going to do for supplies? With that many men and horses on a matted mountainside, the question of how to get supplies through was one that became all important. There was only one answer. Supplies would have to be brought by air.

And they were! A total of 120,000 pounds, everything from eggs and gasoline to baled hay and oats, was dropped by parachutes. Maybe a few of the eggs smashed, but not many, for the foresters in the air figured out some fancy ways of dropping them to the men below. They made egg sandwiches—except that the eggs were still uncooked in the shell—by wrapping slices of bread around the eggs. "Bread springs," they called the lower layers of bread. Radios in cocoons of bedrolls were dropped, lanterns in tents, and half-filled water bags.

Each parachute had a colored streamer attached to it so that the ground crew could locate the packages, regardless of where they fell. The parachutes were dropped from 200 to 1,200 feet.

Naturally, the pilot had to be careful not to drop them in spots where the fire would be likely to beat the ground crews to the packages. The method by which they insured accuracy of aim was simple. The crews selected the best spots, raked away the brush and then set up flags for targets. Sometimes the smoke haze grew so thick that the flying foresters could not see the flags; then the men on the ground used strips of metal or tin pans as reflectors.

Sighting either a flag or a reflector, the pilot of the plane approached, heading straight into the wind. The man dropping the chute let go at what he thought was the best moment. Immediately, the pilot turned the plane so that the dropper could see just how good a hit he made. The dropper observed where the package had fallen, jotted the location down on a map, and when all the load had been dropped, threw the map overboard too, so that the ground crew could refer to it.

It's a neat system. Furthermore, it is practical. If you like both aviation and forestry, here's a chance to work in both fields and get the thrills of each.

But that's not all. The Forest Service not only drops supplies from the air; it drops men too. Smoke-jumpers, they are called—the paratroops of the forest rangers.

Smoke-jumpers are foresters chosen and trained by the Forest Service. Plans are now being made for the extensive use of parachutists at a training base in Missoula, Montana.

The idea of parachuting fire fighters to wilderness areas started in the 1920's. Members of the Service began experimenting and they decided that it was a good thing.

Let us suppose there is a big fire in one of the National Forests today. The blaze has lasted for days. The men who have been fighting it are worn out from their constant battle, and new men are needed. But the fire is raging in an area hard to reach by truck in time to do much good. In a case like this, the work of the smoke-jumpers is invaluable.

Eight men in a squad set out for the fire. Private commercial planes are usually contracted for by the Forest Service and are used during training and for actual delivery. Six- and twelve-passenger ships are the ones most commonly used. The pilots must be highly skilled mountain flyers, for, as a rule, the necessity for smoke-jumpers arises when the flames are at high and comparatively inaccessible altitudes.

The plane circles over the fire area. Again, areas below will have been marked off to direct the men in the air. The flying foresters sitting in the plane have the same adventurous faces and rugged features as their fellow workers on the ground, but there the resemblance ends. In fact they look like men from another planet.

Their uniforms are made of strong duck and are heavily padded with thick, wool felt to keep the jumper from bruising himself against rocks or trunks of trees. The protective helmet serves the same purpose. It has a convex mask of heavy steel mesh so arranged as to hinge down over the jumper's face. His parachute is of a different kind from the standard make. It falls more slowly than the regular brand so that the chutist can take a good look at the land below and steer himself accordingly. There are special guide lines on the chute for such steering.

Another very vital part of his equipment is a small two-way, ultra-high-frequency radio of the same type that the forester on the ground uses. By this the jumper can keep in constant contact with the plane's pilot and his own headquarters.

The plane with its squad of jumpers locates the landing spot. One of the jumpers moves to the door. He isn't ready to jump yet; he's releasing a ten-pound bag of sand with a small burlap parachute attached. He watches it as it descends. That bag is a handy item to test the wind-drift. It looks all right.

Everybody ready? Just a minute. One of the men is complaining that there is something wrong with his parachute. The rangers have a way of taking care of that. One of the young men steps forward.

"Here. I'll check it."

His experienced hands go over the chute carefully,

for he has a parachute rigger's license and he's responsible for the repair and repacking of the parachutes. There's a licensed rigger in every squad.

"It's O.K.," the rigger says.

The boys line up. It's hard to tell what they really look like under those padded uniforms and steel masks. One thing you can be sure of is that they are all young, for no jumper can be over thirty-five. But he must be over twenty-one, and weigh not more than one hundred and ninety pounds. Most of them do not have to worry. An active, strenuous life keeps their muscles lean.

Bail out! There they go. The white silk glistens in the sun as the chutes settle toward the smoky haze below. The Flying Foresters are on the job.

As they descend into the smoke and heat of the forest fire battle, they can be grateful for the careful training they have received.

A strong drift of air may catch a jumper and start carrying him off his course. Flames threaten to tickle the soles of his feet. He yanks on the lines and his swift forward drift stops. His face tightens in new alarm. Underneath him is a huge tree with ugly-looking branches. It might not be healthy to land in that potential trap. Again he pulls on the shroud lines, tipping one corner of the white umbrella above him so that it changes direction. If he did happen to land in a tree in spite of his precautions it might not be too disastrous, however. He wears a unique parachute harness that he can slip

out of easily, and in his equipment is a rope. With a pair of good arms and legs he can usually make it down the tree to solid ground.

Training of smoke-jumpers is usually carried on in the northern Rockies during the last two weeks in June and the first week in July. After two days of demonstration and ground practice, the trainees are ready for their first jump. After two or three jumps, they begin to feel at home in the air and learn to maneuver their parachutes skillfully to target landings. Once they have learned the art, jumpers can manage a safe landing in rough terrain with wind velocities as high as thirty miles an hour and at altitudes up to 8,000 feet.

You might think that it's too risky to be practical, and that accidents would be serious and the rate of accidents high. The statistics argue the other way around. As a rule, the jumpers do not get more than minor injuries and they get those chiefly during the days of early training when they don't know much about their trade.

Smoke-jumping is a specialized technique. It aids the other methods of fire control, but it does not take their place. Its main asset is that it meets the critical problem of fire control in back-country areas. Smoke-jumpers proved their usefulness first when they fought a fire in the Nez Perce National Forest in the summer of 1940. The fire was twelve miles across a deep canyon. If there had been no jumpers ready to leap into action it would

have taken a big crew and a good deal of time and expense to conquer the blaze.

Another big success in the use of planes was at a fire on the Siskiyou National Forest, in Oregon and northern California at about the same period. If planes had not been available, it would have been necessary to truck supplies and equipment thirty miles over tortuous mountain roads and then pack them on the backs of mules for another twenty miles. Such a procedure would have taken twenty-four hours, and a fire can do a lot of damage in that time. As it was, a Forest Service plane took off from the airport at Medford, Oregon, and in fifteen minutes was at the fire, dropping supplies.

If there aren't any planes to be had, then trucks have to do the job as best they can. And they can do a good job too. Service men have designed and built big trucks that look like topless buses. Into one of these they pack horses and mules, ten in all. The horses and mules look fantastic with goggles over their eyes to protect them from the smoke. The trucks roar over the road at fifty miles an hour until they can go no farther. From that point, the animals carry on.

There is a chance that planes may be used in yet another way. Imagine a plane swooping down over the crackling flames in much the same fashion that a dive-bomber lunges for its target. The pilot takes aim. His thumb pushes down on the release button. A shower of bombs rains down over the blazing timber. They crash



The grin on this ranger's face suggests that everything is fine. One part of his work is running a line with a transit like this for purposes of surveying his section of the forest in order to mark off recreation areas, acreage for cutting, or construction sites for dams or bridges. This means usually that he has had a course in practical engineering at college.



Above: Accurate charts and measurements are valuable tools in the hands of the forester. These mathematically inclined rangers get a chance to try their skill in charting a quadrant. Their carefully-planned charts may help later in locating a fire.

Below: This ranger is starting out on a field trip into the mountains. When the road runs out, the horse will carry on through the forest where there are often not even trails.





The forest officer is a master of many trades. Here he is at work on telephone line maintenance. Everything from storms to mischievous birds can jam up the wires, and it's his job to locate the trouble and fix it.



Above: An autogiro lays down a smoke screen of death for the gypsy and brown-tail moths.

Below: Forest war! The plane, with its load of Paris green, is out to annihilate malaria mosquitoes in a Louisiana lake.





A scientist applies a drop of nicotine to a cockroach's heart for purposes of experiment in the control of insects.



At first glance, you might think this man is a fire fighter on the job. Instead, he's spraying chemical death on another type of forest enemy—the gypsy moth.

and a strange fire-killing vapor gushes up through the flames, for the bombs are loaded with a chemical called monoammonium phosphate. The vapor is 200 per cent more effective than an equal amount of water.

Bombs will very likely be used by the ground crews too. A bomb filled with TNT and equipped with a delayed-action fuse may be the fulfillment of the forester's dream of blowing dirt over a fire.

Even after the fire is out, the forester's job is not completely over. Many a "dead" fire only appears that way, and is actually playing 'possum. Men must stay on duty for several days after the blaze is apparently extinguished—just in case. When the Forest Service does a job it sees to it that it stays done.

Although fire is the forester's worst enemy, it may be put to good use. "Fight fire with fire" is a slogan which the green-shirted foresters have occasion to remember at times when they use the method of backfiring, which has been mentioned earlier. This means deliberately setting fire to an area to burn up the brush and vegetable matter so that when the real blaze strikes the patch there will be nothing left for the flames to feed on. The forester has to know exactly what he is doing when he uses this method, for if the backfire should get out of hand it would mean that he had only added more trouble where there was already trouble enough. He used to have to depend on matches or a torch of dried weeds to start such a fire, and he still does if there is

nothing better at hand. Usually, though, he will have a liquid-gas torch. Better yet is a man-packed flame thrower which pumps a highly aerated jet of Diesel oil or kerosene across a lighted wicking, thus spreading flame to all the fuel touches.

Fires scientifically controlled are used a good deal in the South to assist the growth of long-leaf pine seedlings, for instance, by keeping certain types of needle disease in check. The burning of unwanted vegetation and such fire traps as brush and snags also comes under the heading of useful fire.

But in general, fire must be considered the forester's greatest foe. With brawn, brains and courage, the rangers fight back. With those qualities and the aid of new and spectacular weapons on their side, they will make the record of destruction by forest fires a declining one. And you can trust them, too, to meet any new emergency.

A recent headline and the story accompanying it proves how the Forest Service is on the alert:

Japs Drop Bomb
On Oregon Forest;
1st Air Raid on U. S.

Thanks to a Forest Service lookout, Howard Gardner, and an air-raid-warning system of volunteers, the attempt was foiled. Gardner, watching from his tower, saw the flames break out through the tree roofing below—in the

same general area where a vicious fire in the middle thirties destroyed a great forest and most of the coastal city of Bandon.

He sounded the alarm on the telephone, gathered his equipment and raced through the forest by a shortcut to challenge the flames single-handed. Gardner did such a good job that by the time the forest-fire suppression crew arrived after a five-hour battle over rough and brush-blocked terrain, he had the flames under control.

In war or peace, on the ground or in the air, the green battalion is fighting for the V in Victory and the C in Conservation.

CHAPTER V

THE FOREST'S FIFTH COLUMN

THERE is always a savage warfare in the forest. You cannot hear it and you rarely see it, though it rages directly at your feet, above your head, and on every side. It is a fierce and never-ending battle, and it means death to the vanquished. Aside from the fate of the warriors, the life of the trees is at stake too.

If you look closely at the ground and at the bark, you will see the reason: insects—millions of them. Even today, with the foresters attempting valiantly to keep the upper hand, insects over the entire country destroy each year ten times as much timber as fire! In ten years, the spruce-bud worm, an insect working in the young shoots of spruce and balsam, killed over *fifty million dollars' worth of timber!*

Do you see that large ant hill at your feet and the shiny brown ants scurrying over the ground? Don't press your heel down on that cone-shaped mound—not if you want to fight forest enemies like the spruce-bud worm. Those ants forming their brown battalions of attack are

unwitting volunteers in the Forest Service. Compared to the fighting prowess of these small insects, the greatest man-armies in the world make a poor showing. The tiny citizens of only one large-sized ant hill may destroy a hundred thousand forest enemies in a good day's hunting!

The silent saboteurs of the forest have many names and faces, and they work with stealthy destruction, boring from within like fifth columnists. The gypsy moth, nut weevil, pine-bark beetle, white grub, spruce-bud worm, and fungi—these are only a few of them. One thing they all have in common is destruction. If it were not for other insects such as ants and forest vigilantes such as birds, these fifth columnists would soon make short work of our timber. The forester puts up a strenuous battle against such foes, but without the aid of natural forces he could not hope to cope with the silent and deadly army. In their fight for forest perpetuation, today's rangers, together with other forest officers, are finding it increasingly important to wage their own kind of warfare against tree-destroying insects.

Perhaps you wonder what happened when there was no Forest Service to help protect the trees from insect invaders. The chances are that whole areas of forestland were wiped out; in fact, many have been in recent history. Such invasions took place in cycles, whenever conditions were favorable for breeding the enemy insects. There is no way of knowing how often or how severely

the forests suffered in the remote past, but it is safe to assume that entire species of trees may have been swept out of existence.

No matter how expert and persevering the rangers are, they cannot undo in a few years what was done over a period of several hundred years. In pre-forestry days, anyone who wanted to could pack a gun on his shoulder, stroll out into the woods and shoot as many birds as he wanted to for the mere sport of it. Anybody owning timberland—or not owning it—could strike his axe against the trunks and fell the trees in any fashion most pleasing to his temperament. And fire, of course, had pretty much its own way.

Forest entomologists working in cooperation with the Forest Service have classified and studied hundreds of insect enemies. Each type of insect works in a different way; each has a certain tree species which it considers its special tidbit. One of the most unpleasant of these enemies is the bark beetle, and his family includes more than 400 distinct species. He is the most destructive insect pest the forest has ever known.

You have probably seen him, even though you may not have identified him. He looks much like a small, glossy bullet with six legs. And you may have seen some of his work. If the bark of a tree is riddled with small holes, you may feel safe in guessing that the beetle has been burrowing there. He and the rest of his friends bore down beneath the bark of a tree and either kill or

greatly weaken it. Thousands of dollars have been spent to protect the forests from this particular enemy.

The bark beetle does not work alone. An ally of his is the gypsy moth. First of all, the moth is a worm, literally—or more specifically—a caterpillar. Although such an insignificant-looking creature, this moth caused near-panic in Massachusetts, where she first appeared in this country. Brought over from Europe in 1868 for experimental purposes, the gypsy moth escaped almost immediately and began raising a family. The next thing the government bureaus knew, frantic farmers and real estate men were appealing to them.

"You've got to do something! The caterpillars are eating our gardens and our shade trees and our timber to the ground!"

It was the plague of the caterpillars! Men and women looked at each other helplessly. Everywhere the gypsy moth left desolation in its wake. The moths lay their eggs in the trees, and the caterpillars which hatch out proceed to devour the leaves, sometimes even to the last shred.

Girdling insects such as sawflies are no friends of the forester either. They chew away circular bands of bark on the trunks, stems, and twigs of trees, either killing the tree by their activity or leaving it open to attacks by disease. Dead or partially dead trees make a perfect setting for fire.

An insect which wastes no time getting started is the

nut weevil. Before it even germinates from seed, this tiny saboteur with a snoutlike head attacks the forest. Penetrating the soft husk of a young nut or acorn with drill-like weapons, weevils deposit eggs in the drilled hole and sneak on to the next victim. The eggs hatch into grubs; the grubs grow fat from feeding on the kernel of the nut; and finally they bore their way out, fall to the ground, and spend a couple of years maturing so that they can follow in the footsteps of their parents.

The white grub belongs to another unpleasant cohort of the forest's enemies. The brown mother beetles see to it that their babies will not go hungry by depositing their eggs in sod which contains plenty of small roots. After spending the winter in the tasty soil, the grubs come up hungry the next season and they may burrow back into the soil again for another winter or two before they reach adulthood.

If you think of destructive insects in the forests in the same rôle as destructive germs in human bodies, you can see that a healthy forest has the best chance of survival, just as a healthy person has a better chance against disease. With so many villainous insects, however, you might almost think that the forester is defeated before he starts.

But the picture is not that black. For one thing, Nature herself seeks always to keep a balance. Insects eat the trees, but birds eat the insects. When a forester speaks of a "natural forest" he means one where the kinds

of trees now growing are the same as those which grew there originally. Natural forests are the safest from attack, for the trees in such a plot are there only because they have won out as the fittest forms of life to survive.

Then man steps in and destroys the natural balance, usually by wasteful logging. Wasteful logging leaves the ground littered with dead trees, with tree tops and brush, all of which make very cozy dwellings for the breeding of the insect pests. Cut-over land invites fire, and the fire opens wounds in the bark which make convenient entrances for the six-legged invaders. Hunters, storm and disease, kill off valuable birds. Or forest enemies are brought in from other countries, as was the gypsy moth from Europe, or the Japanese beetle. Weather conditions, too, are often in favor of the destroyers, and this is something over which men obviously have no control.

Well-meaning citizens with no scientific forestry training may set out trees that are perfect food for destructive insects. Man-made forests that do not imitate natural forest conditions are likely to be doomed. For instance, in a region where such a tree as the white pine grows spontaneously along with oak and maple, it would be tree suicide to plant the white pines alone. Insect attack is always worse when a forest is made up of just one species, for then the conditions are perfect for the feeding and breeding of the enemies of that particular type of tree.

A good example of this is in New England, where

there are many white pine plantations. The foresters have a real challenge here in order to keep beetles from destroying the pines.

On these same plantations the situation is strikingly like a military conflict. Where the pines grow over a wide area with no other types of trees in the vicinity, the beetles swarm upon them in large numbers like an attacking force of light bombers. When a few hardwoods such as oak or maple are scattered among the white pines, something very different takes place. The beetles zoom on their way much like bombers scared off by anti-aircraft defenses too strong to penetrate.

What can the forester do against the hungry hordes of crawling and flying destroyers? Here, as in his work with forest fires, his best offense is a good defense. And his best defense in this particular struggle is to imitate and improve upon nature's own defensive weapons—in brief, to maintain an all-round healthy forest.

Supervising all logging operations is one way of doing this. Enforcing regulations in cutting, burning the brush afterward, and removing unhealthy and diseased trees all contribute to keeping a natural forest. Sales, grants of free timber for public construction, and free use give the forester a chance to get rid of insect-infested trees. Snags are often honeycombed with insects, so the forester removes them. If he has such an area as the white pine plantations under his jurisdiction, he sees to it that protective types of trees are introduced.

In spite of all such precautions, insects do come and they do cause extensive harm. When that happens, methods of control must be applied. In small areas, poison may be sprayed on the leaves. For large forests, such a method is usually much too difficult.

There is no real answer yet to the problem of control of big timberlands. One of the spectacular experiments has been the use of planes. The airplane skims dangerously low over the forest. Behind it trails a long streamer of whirling white dust. The white dust settles slowly over the green tips of the trees, sifts through the branches and coats the forest floor. The powdery substance spewing from the hoppers of the plane is lead arsenate, a poison to send the insects scurrying on their last legs. Such a method sounds like a good idea and may develop into the answer the forester is seeking. For the time being, it is generally impractical except on a small scale. A better answer may be that of seeking out the forest's friendly insects, breeding them, and letting them loose on the destroyers.

Whatever the answer, you may be sure that the men in green will find it. Against other natural enemies like snow and ice, strong winds, lightning, and blowing sand, they can only grin and bear it. Against the insects, where there's a will there's a way, and the foresters in Uncle Sam's service have the will.

The forester has the help of, and is largely dependent on, government research scientists and specialists in many

phases of his work of keeping a healthy forest healthy. In National Forests there were destructive outbreaks of beetles in Oregon, Utah and Idaho in 1940-41, and localized attacks elsewhere. Altogether, it was necessary to treat 61,400 trees, on 455,600 acres, with chemicals obnoxious or deadly to the beetles. This work was done in close cooperation with the U. S. Bureau of Entomology and Plant Quarantine.

The Forest Service and other related bureaus work together against the forest's other great enemy, fungi. You have probably seen the mosslike growth, the scaly green patches, and various other kinds of blotches on the bark of trees. Such fungi are parasites, for they do not earn their own board and keep; instead, they attach themselves to the living trees and live off them. It makes no difference to them if the tree is a sapling or a giant. It doesn't even matter if the tree is dead and already sawed up in the form of lumber. To the fungi, wood is wood. One form of fungi called the chestnut blight almost exterminated the chestnut tree a number of years ago and killed over fifty million dollars' worth of timber.

The fungus is spread by wind and birds. It works in through the bark of the tree, spreads swiftly around the trunk, and eventually cuts off the flow of sap.

If you see a tree with toadstools sprouting along the trunk you may feel quite sure that the tree is the victim of rot—white rot, heart rot, white-pine blister rust, or any other of the fungus diseases. About the only practical way the forester has of combating this enemy is to cut

down the infected trees before the disease spreads throughout the whole community.

Since a number of these diseases have been brought from foreign countries, the plant quarantine service examines any doubtful specimen being carried across our borders.

Have you ever seen a porcupine sharpening his teeth on a tree's bark, or a deer nibbling at the delicate leaves of young saplings? The porcupine may look very amusing and the deer beautifully graceful. Nevertheless they must take their place in the list of forms of wildlife often injurious to the forest. In the Kaibab National Forest in Arizona, deer have done so much damage that permission was granted to shoot does so as to reduce the herds. Though beavers are assets in some ways, they are liabilities in others. They do great damage by chewing or felling trees indiscriminately. In the Rocky Mountains and in the Adirondacks they have sometimes destroyed an entire stand near their dams by raising the water level so high that it flooded the area. Rabbits, squirrels and mice contribute their bit in destroying seeds, young shoots and buds. What little damage the birds do, they make up for in their assault on insect pests.

The enemies of the forest work together, each preparing the way for the other. But the forest rangers and all the rest of the men in the Service right down the line work together too, forming an increasingly impenetrable barrier to attack on our forests from any and every quarter.

CHAPTER VI

"T-I-M-B-E-R!"

THE wooded hills echoed with the sound of steel on wood. The trees went down in mighty swathes wherever the men approached. The silence of the forests was broken by the challenging sound of their voices. From Maine to Oregon and from the Great Lakes to the Deep South, the invaders spread with a growing swiftness. As thorough as fire and as destructive as insects, the human army came on—the Bangor Tigers of Maine, the silent Finns, the Russians, the French-Canadians, and the Negro gangs. It was an army of strong, adventurous men with crosscut saws and axes and with only one object in mind: "Cut 'em down, boys, before somebody else gets the jump on us!"

They did a thorough job. They did it so well that suddenly a lot of people began to ask, "What's happening to our forests?"

The answer was everywhere around them. The denuded hills bristling with tall stumps and scrub growth told the story plainly. Later, swirling floods gave their

answer too, for there were no long tree roots to reinforce the soil. Banks along the rims of streams and rivers are like dikes keeping the water in its place. Without trees, the soil washes away much faster, and when there are heavy rains the rivers go out of bounds, cutting channels through meadows, washing out roads, destroying bridges and creating general havoc.

With our modern preoccupation with metals, glass and plastics, people sometimes forget the importance of forests. But from the time of the first colonists we have been the greatest nation of wood users in the world. Wood was as important to the colonizers as the bread they ate and the clothing they wore. The first mills to spring up around growing settlements were sawmills. Even in those early days there were local wood famines. The sawmills took the best trees out and left the others to look after themselves, with no thought of conservation or of future crops. When the forest was exhausted, the mill closed its doors or went back over the cut-over area again and stripped it bare even of the inferior types. It was a good way to create a desert.

As the population moved steadily westward, the mills went with them—and the forests disappeared as they went. The migration is still going on, and in the West is America's final great stand of timber.

Aside from all the other uses of wood, its use in paper alone is enough to make you realize the value of keeping a new crop growing for every one that is cut down. A

Sunday edition of just one New York paper needs eighty acres of wood!

"But," someone may protest, "what good are the forests if we can't use them? How can we help cutting them down?"

Scientific forestry, as demonstrated by the U. S. Forest Service, has the answer to that. Cut the trees, yes, but cut them wisely, not wastefully. Trees, like everything else, outlive their usefulness, and when they have grown to ripe maturity they should be felled to make way for the young growth struggling to take its place in the forest. Logging operations take place on the National Forests whenever it is wise or profitable, and the Service employs a special type of worker to supervise this process. He is the logging engineer, a trained forester who knows all the ins and outs of cutting timber. He knows all the answers to the "when, how and why" of logging.

This forester's work depends not on big muscles nor the ability to wield a steel blade like a modern Paul Bunyan, but on his ability to plan, organize and control the felling of trees so that it is to the future good of the forest instead of its destruction.

The main purpose of the Forest Service is not to maintain the forests for the sake of their beauty, though that is important. That part of the job is taken care of in the setting aside of scenic areas like Mount Rainier National Park, or Glacier, Olympic, and Acadia National Parks, to mention a few. The paramount purpose is to keep a



Behind the battle lines of insect control. Laboratory workers inspecting cotton bolls in the fight against weevils and pink bollworms.







Above: This government worker is an ally of the ranger. He is an entomologist examining an insect trap to see if the destructive Japanese beetle is carrying on its work in the vicinity. If so, he and his fellow entomologists will take steps to destroy the beetles by spraying chemicals or cooperating with the rangers in removing trees and bushes that may be harboring the insects.

Upper left: When the ranger receives these trees from the government nursery he can feel sure that they are free of insect pests. Here, two quarantine workers treat a nursery tree with a chemical solution which will guard it against the Japanese beetle.

Lower left: The weapon in the hand of this worker is a vacuum lifter removing parasites from Japanese beetles. The parasites will be transferred to rearing trays of beetle grubs for further observation.



Japanese beetle traps. Harmful to forests and farms alike, this insect accidentally introduced from Japan is a welcome visitor to traps like these set out under the supervision of the Bureau of Entomology and Plant Quarantine.



The forester and the farmer have worked together to raise this fine stand of timber, and they will go on cooperating in a plan for its use. Forestry handbooks and technical guides in scientific forestry help contribute to success in conservation farming. Forestry and farming make good friends.



This forest officer is scaling logs. Scaling means measuring logs by a given log rule or scale. Proper deduction must be made for crook and crotch defects, unsound sap, worm holes, scars, seams and all other blemishes. By his calculations, the forester can tell how many board feet the timber contains, a fact necessary in timber sale and utilization.

perpetual timber supply for the citizens of this country. Instead of the hit-or-miss method of the old sawmills, the towns supported by the wood industry of the National Forests are on a stable basis, with an eye always to the future instead of on profits merely for the present. The timber in these forests does not always demand a cash return. Some wood can be obtained from the Forest Service free, or at a very small cost, by settlers in and about the forest who need fuel or logs for their personal use.

Big sales are made to private companies, however. Whether the district ranger, the supervisor, or the logging engineer handles these sales depends on the size and importance of the transaction. Whatever the case may be, foresters usually precede the private loggers and blaze all the trees that are to be cut, that is, chip out a piece of bark to mark the tree. The logging engineer or another forest officer later measures the logs as a basis for payment. If the wood is regular timber—wood used for lumber—it is sold at so much per board foot. If it is to be used for fuel or pulp wood for making paper, the cost is so much a cord. Ties and posts are priced per piece.

So the National Forests are a business whose product is wood. As soon as the wood is ready it goes to market. In many ways, then, the logging engineer is a business-man in a national industry.

Before wood can be sold anywhere, somebody has to

make an estimate of the standing timber. That person is called a cruiser. The cruiser may be the logging engineer himself, a ranger, or any other qualified officer in the Forest Service. He is the advance scout of any logging operation. Every logging company has one or more of these men, and their trade is one which requires real forest knowledge.

It is a strenuous and fascinating job, this business of scouting the forest. Usually the cruiser sets out into the woods with a compassman and a cook, prepared to spend anywhere from seven days to seven months in getting the answers to such questions as these: How much wood is there? How valuable is it? What species are there? Will it cost more to get it out than the wood is worth?

The cruiser tramps up and down a section on four or more parallel strips sixty-six feet wide. He works with the thoroughness of a detective. As he travels over swamp and brush and through ripe stands of timber, he counts, grades and measures every tree within the strips.

You can see that it would be impossible for one man to cover an entire forest of any size in this fashion. The cruiser doesn't have to. Instead, he covers about five per cent, sometimes more, of the section, jotting down every fact pertinent to his record.

There is a tree crusted with fungi. The cruiser makes a note of it and other similar diseased trees around it. Here is a group of elms mixed in with fir. That goes down in his notebook too. He shades his eyes against

the gleaming sun as he stares up at the stately tree towering above him. There's a nice piece of lumber. But that's not enough information for a technical report. With his measuring instruments, or merely with the measuring judgment of long experience, he calculates just how much lumber an operator can expect to get from the tree. He judges that the tree is three feet in diameter and a hundred feet tall. That averages 2,500 feet of lumber. His report, when it is finished, will show just what timber should be cut, what should be left, and how the job should be done to get the best results.

In most forests, the trees are likely to be of all sizes. The forester's job is to take out all the trees that are large enough for cutting and that can be spared. At intervals, he may leave one tree remaining in a lonely, cut-over spot so that it can drop its seeds on the bare ground. He does this even though there may be seedlings already springing up among the stumps of the freshly felled trees, for seedlings have a high rate of mortality. Light fires, drought, storms, or any unusual condition may kill them. Even if the seedlings are destroyed by a light fire or a storm passing over the area, the big seed tree has a good chance of outliving the peril, and thus it is like an insurance policy.

Since it is part of the logging engineer's responsibilities to see that scientific cutting takes place, he must know that different species and different climates require different methods. Where nearly every tree is felled during

lumbering, as in the Douglas fir forests of the Northwest, the area is set on fire. It is burned over as soon as the logs have been taken out. The reason for this is that the fire destroys the brush and matted growth which would make a canopy over young seeds. Millions of fir seeds have been accumulating in the top soil, and they need a chance at the sunlight. With the brush burned away, they sprout and start another fir forest on its way.

Once above ground, the seedlings must be protected from any further fire. Otherwise, not only would they be lost, but there would be no more living seeds stored in the soil, and the only way to get future trees would be to plant them by artificial means.

High standards of felling are practiced on the National Forest timber sales. So simple a thing as the height of the stump left is important. Generally, when trees are felled, a notch is first made with an axe, and then two husky loggers take their places on each end of a crosscut saw and finish the job. It would save a good deal of perspiration to saw at about the level of a man's waist rather than to crouch down low. But the Forest Service says cut them low—and it means what it says. Leaving high stumps is wasting wood.

Picture a forest giant being cut. The tune of the saw changes gradually as it works through the cut. The men shove the glistening blade back and forth, back and forth. A few moments now and they will get out of the way.

"She's ready!" one of the men says.

If it is a fairly small tree, one of the men can send it crashing in the right direction by giving it a shove. On a really tall tree, cables are attached to pull it in the predetermined direction.

"Timber!"

The long trunk wavers a moment. A long, creaking sound goes down the length of its body. Then it swoops down, the small remaining portion of its still attached trunk ripping free. It thuds against the ground, a log instead of a tree. That is all there is to it—if you are watching lumberjacks who know their forestry.

Something else could happen as the tree goes crashing down, and all too often does, when a man like the logging engineer in the U. S. Forest Service isn't around to check up. The operator interested only in getting the big trees out in quick order often destroys more wood than he gets, for as many of the trees fall their big branches tear at the trunks and limbs of smaller trees standing near by. The smaller trees may be critically mutilated or broken, so that actually a dozen trees are lost in the process of getting just one.

Transporting logs is another danger spot. Skidding the logs along over the forest floor, for instance, often rips and tears the young growth. Sometimes a cable is fastened to a log or logs. Then the logs are hauled out by pulling and jerking them along at the end of a cable which is rewound on a drum at a donkey engine. What-

ever is in the way gets the full brunt of the swinging, skidding logs.

Much better in skidding operations is the tractor. It hauls single logs and bunched lots which can rest on a flat steel pan or be swung under a steel arch so that only the rear ends drag.

Whatever method of skidding is used, the logging engineer sees to it that every possible precaution is taken for, as is true of all the other men in the green forester's uniform, his first concern is the forest itself.

Of course, the logging engineer has to understand the private operator's problems too. The prices set must allow the purchaser of National Forest timber a fair profit. Bids are obtained by public advertisement whenever the area to be logged warrants it. Where it is reasonable or wise, the logging engineer makes sure that the proper information is given out and that the conditions of sale are understood. On the whole, the logging engineer worries about the sale of large areas and leaves the small timber sales up to local forest officers.

There is a definite relation between tree sizes and profits. When the trees are small, the logging costs per thousand feet are high. The larger the tree, the lower the cost. When lumber is being sold for good prices, small trees can be logged profitably.

Places where the trees cannot be logged in any case are the National Parks. Another place where the forester

will not allow trees to be cut at all is on steep hillsides. There the trees act as a living dam. The removal of even a few might loosen the soil so much that the moment there is a heavy rain the soil would start washing away. Soil on the move is hard to stop; once it has started it acts much like a snowball rolling down hill.

The forester cuts trees for other reasons than sales. There are six different ways to cut a forest that have little to do with utilizing the timber. These are for maintaining the forest's health.

One type of cutting is called *cleaning*. This is a cutting made in a young stand, not past the sapling stage, to free the trees from others of the same age which are undesirable types. Some species are considered worthless. Or they may have grown so large that they are taking up all of the space for themselves and not giving the underdogs even a fighting chance.

Liberation cutting is a method used in a young stand that has not passed the sapling stage. The forester's aim in this case is to free the youngsters from "wolf trees" which are overtopping—stretching above and over the saplings so that they do not get their due portion of sun and moisture.

If there are too many trees rubbing branches in a small space, none of them is going to get much out of life, for there are too many of them feeding on the same soil. Here the forester employs *thinning*, which means

just what it says. In such places, the logic of cutting is that it is better to have ten tall, healthy trees than a hundred midgets.

Improvement cutting is another term that can be taken at its face value. By this means the forester gets rid of poor-quality trees so that only good ones are left.

In *salvage cutting* the forester gets rid of trees damaged by disease, insects or fire.

Finally there is *pruning*, and that is a familiar term, since pruning is used not only in forests but in groves and hedges, and on fruit and shade trees. It means removing dead branches or unneeded living ones from standing trees in order to make the final product better. It reduces the size and number of knots.

In recent years, extensive thinnings and improvement cuttings have been made by the Civilian Conservation Corps among the National Forests of the Lake States.

Private industry is learning, too, that scientific forestry pays dividends, whether the final product is lumber, paper pulp, charcoal, or a number of other things. It used to be that standing timber cost next to nothing. The mills could move into the heart of the forest region and pitch in. Today, the mills are often at long distances from the timber they own, and transportation costs are forcing the lumbermen to study what they can do about creating man-made forests similar to the National Forests. In the East it costs from fifteen to twenty dollars a thousand board feet for transportation—to say nothing

of all the other costs the private owner has to bear. Therefore forestry is assuming a vital importance to the private owner and he must plan for both the present and the future. Here is a growing field of employment for the trained forester.

In wartime our forests have to meet more demands than ever. It has been said that "to be without wood in time of war is almost as bad as to be without bread." Wood is needed for the construction of barracks, boxes, airplanes, powder, shells, ships and many other products. Ships alone, in spite of the steel used in their construction, use vast quantities of wood. A modern battleship takes more than 300,000 feet of wood. Boxes may sound like a small item, but actually the largest single use of wood in war, aside from camps and defense housing, is in the box-making field. Tanks, shells, bombers and planes need lumber for crates.

On whatever lumbering front the forester works, he has a busy and exciting time of it. For his specialized services, the logging engineer in the Forest Service gets from $4,000 to $5,000 a year. It is work that is packed with pleasure and real meaning, not only for the forester himself, but for all the men and women in the United States who realize that forestry has a big part to play in war or in peace.

CHAPTER VII

FOREST FORTUNES

EVERYBODY agreed that it was a strange sight. Magnus Benson was probably getting a little off balance from too much work in his fields, they decided. For nobody could compete with Magnus when it came to hard work. He planted and harvested the best grain crops in the country. But now! Every day Magnus was out working beside the highway that ran past his farm and he was busy planting—not rye or wheat—but trees!

"Maybe he's got a bad case of spring fever," one of his neighbors said. When he approached Magnus himself he was more diplomatic. "What're you planting all those trees for? Most folks are getting their fields plowed right now."

"Don't you worry about my getting my plowing done," Magnus said, straightening up from the maple sapling he had just planted. "What I'm worrying about is my taxes. That's why I'm doing this."

"What's trees got to do with taxes?"

"Don't you ever read the papers? The State says that

anybody who plants forest or shade or fruit trees along a public road like this one here will get an abatement of his highway tax—one dollar for every four trees set out. Mister, I'm going to have a regular grove before I'm through."

Such was reforestation in its infancy in New York State in 1869. Here and there a few voices were crying out in the wilderness of forest waste, demanding that something be done either to conserve the trees that existed or else to plant new ones in their place. There had been other voices before them, but not enough.

William Penn made an attempt to regulate the wholesale slaughter of forests in his time by imposing some simple forestry laws on his colony. Because of the need for oak trees in the construction of ships in the early part of the eighteenth century, the colonial government set aside a reservation of live oaks and tried rather clumsily to plant and care for such trees.

Among the immigrants who came to this country there were many who had had experience in forestry in the old countries of Europe.

"You won't have much left of your forests at this rate, monsieur," a newly arrived Frenchman might tell a pioneer American. "After our revolution we made the same mistake of leveling our timber to the ground. Not any more, monsieur. Not after the floods started washing away our homes—provided we had had enough wood to build a home."

Now that so many of the forests are gone, it is hard to imagine what the country looked like before the great treks westward. Some of the forests were so deep and dense that even the Indians feared to venture too far into them, thinking that they were haunted by evil spirits.

Reckless exploitation of the forests is by no means something peculiar to our country alone. Nations all over the world have followed the same cycle of destroying their timber only to find out—perhaps just in time, perhaps too late—that their only hope lay in conservation and reforestation. In Europe, for instance, Sweden and Finland are the only countries that still have as much as half of their original forests left. Russia can boast of the largest forests in the world. Following in order of their timber resources are the British Empire, Brazil and the United States.

It is hard to estimate just how much wood is grown each year in all the world's forests, but it is believed that it is much less than what is used up. One thing is sure—the days of cheap, wild timber are over. Today the government is making a heroic attempt to stabilize the use and cost of wood by substituting man-planted forests. The keynote of the whole effort is cooperation on the part of the federal and state governments and private industries. Because of cooperative legislation, farmers and communities receive seeds and tree plants distributed for windbreaks and plantations.

If you have ever seen a government tree nursery, perhaps you were struck by its similarity to a great garden. There, neat plots of seeds grow to seedlings in orderly, green rows. Sprinkling systems send a fine mist of spray over the young crop. A forester, hose in hand, may be seen walking between the rows. Each plot has a small sign sticking up from it telling that it is Douglas fir, lumber pine, Santa Fe spruce or whatever it may be. From these gardenlike plots will come many of the forests of the future.

But the army in green has an uphill battle on its hands. Our rangers like challenges to their ingenuity and courage, but they are not afraid to look the stern facts in the face.

"There isn't any need for our country to go into forest bankruptcy," any of these determined young foresters working for Uncle Sam will tell you. "Some of the facts don't look so good, but with good hard work and cooperation we can change those facts around someday." His eyes gleam and you know he is thinking of the future, a future that the Forest Service wants to plan on a much vaster scale than the present.

"Most of us figure the government should go on adding to the National Forests as the best way to insure the future." He points to the rows of nursery seedlings. "What we need are lots more just like those."

"But won't that mean a lot of money out of the public pocketbook?" you may ask.

The forester knows the answer to that one. "It will be a lot cheaper in the long run!"

Reforestation is the answer to deforestation. The crux of the matter is that it takes so much longer to grow a forest than it does to cut one. Statistics may not seem dramatic, but they present the true picture in startling terms. We have cut down and ruined about a hundred million acres of virgin forest. We have planted a little over one and one-half million acres! Or put it this way: In a year we plant about the same area that the lumber industry cuts over in four days!

So you can see that the rangers are pioneers in their own field and that they have many odds to overcome. Give them time and with the help of everyone concerned —which means every citizen in the country—they will change those gloomy facts and figures to something much brighter.

Just what does a forest ranger do when he comes up against a section of land that seems to have nothing but wild, bare stretches denuded of everything but rotting stumps and tangled brush? Provided the soil is good, the forester does just one thing—he goes to work.

You are making a mistake if you visualize the forester planting a new crop of trees in somewhat the same way that the sowers in familiar pictures stride over the hills flinging handfuls of seed to the wind as they go. Instead, picture not only the ranger, but his helpers—guards and

forest laborers—going out to the planting grounds in a caravan of trucks and cars. Generally they set out in the spring or fall, the best seasons for such work. In the spring, the forester puts his crop in when the frost leaves the ground; in the fall, before the frost comes back.

Big trucks, manned usually by forest laborers, bring him the stock of young trees from the government nurseries. The trees lie in even rows in the truck's trailer, their roots wrapped in moist burlap bags. At this stage of a tree's life span, its roots are its most important part. The ranger sees to it that the saplings are taken out of the truck as swiftly as possible, for even the wet moss packed around their roots will not keep them moist very long.

Suppose a storm comes up suddenly, or there is a fire in some other part of the forest, where all available help is needed. Since time is important to those saplings so recently dug up from the nursery, what will happen to them if they cannot be replanted immediately?

"We've got to make tracks, men," the ranger tells his crew. "That storm blowing up from the south isn't going to wait very long to strike. Heel 'em in."

The crew understands his command. They go to work digging a long trench with one side slanted slightly, the young trees to be leaned against the slanted side. First, they make sure that the thin, dirt-caked roots are thoroughly wet, then they cut the strings which bind them

in bunches. After the workers have put the trees in the trench, fine soil is placed around the roots and packed down gently with their feet.

If it is impossible for the ranger to tackle the planting job immediately, he makes arrangements for the roots to be kept moist. Even an hour's sunlight may dry the roots so much that they will be of no use.

But if everything goes well, and it usually does, the planting begins as the young trees come from the trucks. The men are not able to plant all of them at once, so they pack damp moss around the roots. Or they use the method of *puddling*. They make a puddle of water and fine soil and then dip the roots in the puddle. After that they put the trees in buckets with damp material guarding their roots as they are carried wherever needed.

The ranger doesn't waste time. He has everything well organized beforehand. Neat, plowed furrows are ready. The planting is done with order and exactness, and this makes it easier to estimate the number of saplings needed. It saves time too.

The men are all set, their tools in hand. Among their planting tools are the mattock (a digging implement resembling a pick), grub hoe, spade, or other similar tools. A worker with a mattock will go about planting the tree in this way:

In his left hand he carries his supply of trees in a box or pail. When he reaches the proper spot in the furrow, he sinks the mattock into the ground. One good stroke



Snow patrolmen. On April first, the snow in the Western ranges is, on the average, at its deepest, and snow surveys are made to forecast the amount of water which will run down from the thawing snow.



The information this patrolman obtains after taking a sample of the snow will be relayed to the Department of Agriculture. A forecast of the amount of water which will run down the slopes is of vital importance to farmers, ranchers, engineers, businessmen and foresters alike. This hollow tube has a series of slots along the side and when it is pulled up will contain a core of snow.



It is not the depth of the snow that counts, but the net water inches. To find that out, the snow is weighed by suspending the long pole from a scale. Snow patrolmen may be rangers or other officers recruited by the Department of Agriculture from federal, state, or private agencies.



What kind of trees, crops or grasses will best grow on a piece of land? This technician can tell you after making a survey. Here he has just taken a sample of earth with a soil auger. Soil conservation and forestry are interrelated factors and act on each other.

will usually make a hole big enough for a two-year-old seedling. He must make sure that the hole is large enough to allow the roots to spread out. The worker will have to use his judgment as to the size and depth he needs, depending on whether the tree is two or three years old. The important thing is to make room for the root system.

That done, and the roots well saturated with water, the young tree is ready to be set in. The worker sets it in as deep as it grew in the nursery. There will be a collar mark on its stem to guide him. He must make sure that the roots are well spread out and filled in with loose dirt. He will not put sod or leaf litter next to the roots, although he may use them to fill up the top of the hole. He holds the tree in position with his left hand while he uses the mattock to scrape the soil over the roots. If he is an experienced planter, he does all this with mechanical swiftness, and he can plant as many as two thousand trees in a day.

The final step is to pack the dirt firmly around the tree with the heel or toe of his boot so that it will stand upright and cannot be pulled out easily.

That ends the worker's rôle. From there on the tree is on its own. If it is good stock and not damaged by natural enemies, it should do well.

Sometimes seeds are planted instead of young trees. Arguments against the use of seeds include the fact that they are often costly and hard to get. A research scientist

working in a Forest Service nursery may have a good deal of trouble getting the kind of seeds he wants. A number of years may go by in which the mature trees do not produce good seed crops. Or, even if they do, the job of collecting them may be difficult. Light seeds are blown about by the wind. Easiest to obtain are beechnuts, acorns, walnuts and other such heavy seeds which can be collected from the ground. The work of collecting seeds falls to unskilled laborers hired by the Forest Service for this purpose.

The scientists at the government research stations carry on from there. The seeds are stored in a cool dry place until they are wanted. Pine or fir cones must be carefully dried, for they have a tendency to become hard on the outside if they are rushed, and it is difficult to open them to release the seeds. In the drying-out process, modern kilns with delicate temperature controls are often used. The removal of seed from the cones may be done by ingenious inventions of the revolving-cylinder and shaker type, with slits or holes large enough to emit the seed but not the cones. After this has been done, the seed is shaken around to rid it of its wings. Then it is ready for storage—or for the foresters.

In the planting of seeds, just as in the planting of seedlings, the forester has to see to it that everything is ready for orderly and swift planting. Crews armed with spades will "spot plant" the seeds, that is, a single spadeful of earth is loosened for each seed. Foresters seldom

risk the mere scattering of seeds loosely over the ground, because they are too easily washed off or carried away by birds and rodents.

The forester may do some work in reforestation by "wild stock" methods. That means selecting small wild trees already growing near the area where he intends to plant. Wild seedlings have a more tender root system than those provided by the nurseries. If the roots are more than eight inches long they are cut shorter. The seedlings should not be much over three or four years old.

Occasionally in experimental work or in restoring vegetation on a road bank or stream bank, foresters plant trees through the use of *cuttings*, sometimes called slips or shoots. Experimentally, these are not used for many species other than cottonwood and willow. The cuttings are taken from the ends of twigs or from older wood. Shoots should not be cut from wood that is less than an inch in diameter, nor should they be more than twelve inches long. The top is cut off just above a healthy, vigorous bud. If the cuttings are gathered before frost in the fall, they are stored in moist sand over the winter, and then planted in the forest furrows in the spring.

In planting, the crews place the cuttings carefully in the soil so that only a short portion of the stem and the top bud are above the surface.

While timber is being cut down to aid the war effort, the uniformed guards of the forest know that reforesta-

tion must not be forgotten. Gifford Pinchot, pioneer forester and former Governor of Pennsylvania, is even now making a plea for legislation that will guarantee forests for the future as well as for the present. "We shall need more wood, vast quantities of it, after the war is won." Bills are pending in Congress that would establish some measure of control of logging on private lands. Conservationists insist that sufficient lumber for the war effort can be obtained under approved forestry practices, without leaving wastelands behind.

And the trees, in many and various ways, repay us for all these efforts. Besides timber, they give firewood, paper, maple sugar, fruits and nuts, turpentine, rubber, resin, and all the varieties of by-products being created by modern chemistry.

The forest ranger's place in the country's progress and welfare cannot be overestimated. To him, trees are a trust and a heritage. He uses patience and foresight in his job. He knows the satisfaction of creating where others have destroyed. Whether it is "forest farming" or forest fires, the forester keeps forging ahead toward the ultimate goal—the growing of timber on every acre of available forest soil.

In the Forest Service, every day is Arbor Day.

CHAPTER VIII

LET TREES DO IT!

THOSE clouds on the horizon look as though they might be coming from a raging forest fire. But there is no smell of smoke in the air, and there aren't any flames. The swirling clouds are so high that aviators cannot fly above them. They extend so far that sailors two hundred miles out at sea see them and wonder. People in the streets of Eastern cities gaze up at the sky to see if there is an eclipse of the sun.

Back on the plains where the strange clouds have their beginning, grim-faced men choke for breath as they watch their farms and fortunes go up in dust. For dust it is—but not common dust. Those clouds represent millions of acres of fertile soil, millions of tons of rich farmland, and millions of dollars—all of it blowing sky-high. Gypsy soil. The earth is on the move!

"What shall we do?" the desperate farmers ask. "What's going to happen to our livestock and fields?"

The Soil Conservation Service gave part of the answer during that great drought of 1934: wise planting of vegetation, terracing of the ground and the building of dams.

The Forest Service could give another part of the answer in one word—trees!

The farmers themselves are responsible, as often as not, for the depletion of their woodlots and the consequent damage to their fields. Even the best farmer, one using all the modern scientific means of making his fields rich and productive, may never give a thought to using the same scientific methods in the management of his woods.

Yet the farmer is our greatest wood user. He is one of the great wood owners, too, for farmers own about one-third of the forested land in the United States. Teaching the farmer how to care for his woodlots and how to get the most out of them is a part of the problem of forestry and soil conservation.

Forests have a much greater effect on climate and other factors of environment than most people realize. Some authorities say that the cutting of forests in great quantities decreases the amount of rainfall. One thing that is definitely known is that forests do make a land more temperate and less subject to extreme changes of temperature. Trees absorb heat from the sun and store it in their trunks. At night when the air cools, they give some of this heat back. If you have ever been on a desert you can realize better what a difference the lack of trees makes.

Forests are like walls protecting regions from winter blasts and the hot summer winds. For this reason the

forester may recommend to the farmer that he plant a long belt of trees in the most strategic position on his grounds. Lombardy poplars, locusts or evergreens are often planted for such windbreaks. If there are sand dunes near by, the green wall keeps the sharp particles from whipping across the farmer's fields. Such sand can do a pretty thorough job of ripping grain and plants, aside from burying roads and even covering buildings. If you can get trees to root in such an area they will help block the force of the wind while their roots keep the sand in its place.

Forests have a great influence on streams. This influence can mean the difference between a pleasant brook or a raging torrent. Trees put a roof over the ground and cover it with a protective carpet as well as holding it in place with their strong roots. Rain falls lightly beneath trees instead of with hammering force. The upper soil is porous and absorbent. Running water finds countless obstructions on the forest floor matted with old leaves and dead twigs. On millions of acres trees are nature's most faithful protectors of the soil. On the steepest slopes, up the rough banks of ravines—in places where nothing else is so well fitted to do the job—trees hinder the flow of running water and hold the soil in place. The Soil Conservation Service, started in 1933, works along such lines as this. It combines engineering, forestry and crop control.

Erosion—the washing away of soil—is one of the

greatest of the farmer's natural enemies. Here is a picture of a typical farm where erosion has set in. A river runs alongside a big area of pasture land. It looks harmless enough most of the time, a small, winding body of water shining like a mirror under the sun. But watch what happens when there are heavy rains or thaws. The river swells. Swirling water creeps up over the banks, and as it gushes over the land bordering it, it carves out gashes and cuts into the soil. There is nothing to stop it. The trees that would have served that purpose have been cut down. Only a few rotting stumps are left.

Behind the farmhouse there is a danger zone that operates in just the reverse fashion. It is a miniature dust bowl. Here the farmer has cut down a long stand of trees for fuel and has dynamited the stumps. Along comes day after day of dry, hot weather. Dust begins to blow. And as it blows it eats deeper and deeper, tearing the earth from what little grass there may be left, burying other vegetation, and eventually spreading farther and farther like a prairie fire.

The farmer faces the forester grimly and wants to know what he can do. It doesn't do much good to tell him that he is trying to close the barn door after the horse has fled. But the man in green can advise him what to do with the cleared land and woodlots that he has left.

He points out the trampled vegetation in one section of the farmer's woods. The villains are in plain sight,

grazing peacefully at a distance beyond—sheep, cattle or hogs.

"Put up a fence here, if you don't want your woods trampled to death," the forester tells him. "A few saplings trying to come up to the east there, but already the sheep and cattle are dooming them to an early death. Good fences are part of the answer."

As the forester accompanies the farmer farther, they may come upon huge piles of brush left from logging operations. "Better clean that all out," the forester says. "Otherwise, when the dry autumn weather comes, fire will go through here like a whirlwind. Lose your trees, and the next thing you lose is the good earth itself."

At another part of the man's woodlot he tells the farmer, "The trees are too thick in this spot. With all those young saplings attempting to grow at the same time in the same place, the upshot of it will be that there'll only be a few that have the strength to survive. Thin them out. Remove the smallest and the weakest and give the rest a chance."

Just ahead at the corner of the section, dead and dying trees are mixed in with healthy, living ones. "What you should do here," the forester says, "is to take out the corpses and put some lusty infants in."

Besides timber improvement work of this kind, the farmer should use a careful schedule of cutting. He should know in advance just which trees to harvest and which ones to leave as maturing stock. The forester,

with advice based on his own experience and well-established forestry principles, can tell him what to do so that he can draw out a regular profit from his timber and at the same time keep his capital intact.

In all of this, the forester is the farmer's friend. The farmer is glad to see the green uniform on his lands and enjoys talking to the hardy young men who are willing to help him wrest a better living from his soil. His part of the job is to keep a simple but complete record of what he does to, and with, his woods—what he plants and what he leaves. With the forester's help he can take an inventory of his woodland resources, and from time to time a reinventory can be made. These records, along with records of the other crops, will show just what effect scientific woodland management has on farm income and increased capital assets.

The state forester can give the farmer information on the market trends of lumber. In some states, the farmer can get seeds for planting or even seedlings for windbreaks free or at a minimum cost.

Aside from everything else that trees do, they help build up the soil and add to its fertility as a rule. But, as previously mentioned, one of their biggest jobs is the help they contribute to the prevention of soil erosion and floods.

Let us consider the process of soil erosion at work. Picture two mountainsides. On one there is an extensive stand of timber. The other is only bare ground, with

here and there a puny shrub. A storm is about to pass over both of these mountainsides. The lightning flickers. Thunder groans over the sky. Rain begins to fall, lightly at first. In fact, if you were standing under the broad canopy of the trees on the one mountainside you might hardly realize that it was raining. The leaves and needles of the forest catch the raindrops. On the other slope, each drop of rain makes a small pockmark on the dusty, unprotected soil.

Presently it is raining hard—great gusts and torrents of rain. Even so, you may still find a certain amount of protection under a spreading cedar or maple. But you can be sure that anybody on the treeless slope is going to be drenched. And so is the soil.

Already, the heavy rain is beginning to carve the soil like a knife. There is nothing on that other mountainside to suck up so much rain. The soil just can't take it. First it gets muddy, and then it starts moving. If the rain keeps up for long, that moving process is not a minor matter. Before the storm is over, tons of dirt may be on their way down to the valley below—rivers of mud, floods of destruction.

For directly in the path of the moving water and earth is a highway, a bridge and an irrigation canal, as well as valuable farm land. It took months and years to build those structures. It can take only a few minutes to tear them apart.

Something quite different happens on the forested

mountainside. The green canopy is getting leaky and the rain has broken through that first line of defense. It beats down on the forest floor itself, but that floor can take a lot of punishment. All the leaf mold and moss and other vegetation drink up the rain before it can get much of a chance to attack the soil beneath. They are like millions of small green sponges soaking up the water. They have their saturation point, of course, and if the rain keeps up too long, water is bound to start running down that mountainside too. But it does not carry tons of valuable top soil as it goes. It is no wild and unrestricted rush. It works its way slowly downward and into the stream beds. The streams swell but the roots of the trees along the banks are guardians that hold the soil from running off with the water on a destructive journey.

Forests alone cannot prevent floods, but they do make a tremendously important contribution to the cause. That is why the Forest Service and the Soil Conservation Service work hand in hand and why their work often interlocks.

In the matter of soil fertility, trees help greatly by protecting the ground from the drying-out and baking factors in too much sun and wind. The falling leaves and the virile forms of microscopic life at the roots of the trees constantly enrich the ground from which they grow.

One of the constructive results of the drought in the Great Plains region was the Prairie States Forestry Proj-

ect, or so-called Shelterbelt Project announced by President Roosevelt in June, 1934. Headquarters were established in Lincoln, Nebraska, and the work was carried on by the U. S. Forest Service until July, 1942. Now it is the Soil Conservation Service's job.

A shelterbelt is a strip planted with trees, which may vary from 100 to 165 feet in width, and extend to a length sufficient to give the greatest protection from prevailing winds. Shelterbelts provide windbreaks, snow-traps and shade in an area where trees are generally missing.

Shelterbelt planting in this country has been carried on over a period of some seventy years or more. Many groves were planted by early settlers on the plains as a result of the Timber Culture Act of 1873. There are now about 2,000,000 acres of shelterbelts. But the recent project for the protection of the Great Plains farms is perhaps the most dramatic of all. The shelterbelts have been planted in an area extending from the northern boundary of North Dakota in a general southerly direction for about 1,000 miles. Even though dust and heat whirl frequently over this area, the region is reasonably productive and should be much more so with this added protection. These shelterbelts of from ten to twenty rows of trees are usually planted at intervals of about one mile. Nearly every type of variation is used in the design of these, depending on the direction of the prevailing wind, topography and other important factors.

The three principal requirements of a shelterbelt are adequate height, length and density. The tallest trees are planted in the center. Shorter-growing trees are used along the sides and shrubby growth at the edges. Evergreens are often used near the edges because their branches grow near the ground and give protection against the upward sweep of the winds.

"Lift up thine eyes to the hills" is more than a Biblical phrase. Every spring farmers, engineers, ranchers, orchard owners and scores of others in the Western States turn their eyes to the hills and the mountains. On April first the snow in the Western ranges is likely to be at its deepest and it is during that week that snow surveys are made in order to make a forecast of the amount of life-giving water which will run down from the thawing snows to nourish plants and turn electric generators.

The men who walk upon the cold peaks in search of data to relay to the Department of Agriculture are men recruited from federal, state and private agencies to brave the frost and winds among the West's 700 "snow courses"—foresters, conservationists, engineers.

The snow gleams like the white frosting on a cake. The mammoth green candles of the evergreens thrust up from the snow. Two rugged young men in ski suits make their way along the fleecy trail. Now and then lumps of snow from the evergreens shift and fall downward with a soft swoop. The young men's faces are a brisk red. The air tastes like an icicle. The snow patrol-

men are on the job, a job that means grazing the sky at anywhere from 6,000 to 10,000 feet above sea level.

They stop to take a sample of the snow. The sun flashes on their dark goggles, worn for protection against the blinding dazzle of the snow. One man has a hollow pole, which he drives deep into the snow. When he pulls it out again, he studies it carefully. The pole has a series of slots along the side and is filled with snow when it is pulled up. It is not the depth of the snow that counts but the net water inches. To find that out, the other man weighs the snow by the simple process of suspending the long pole from a scale. That is all there is to it so far as taking the sample is concerned, but when the findings are flashed by radio and spread by the leading news services the people affected by water supply listen intently, for the data can mean bright prospects for the future, or gloomy ones.

The snow patrolmen dig pits in the snow too, and make a detailed analysis of each layer. These pits are dug on certain key snow courses.

Sometimes blizzards force the snow surveyers to make a run for it, to one of the shelter cabins built on the remote snow courses for workers who have to travel far from their base camp. Or they may make their headquarters in one of these shelter cabins indefinitely, for each cabin is well provisioned. Such a structure is not an ordinary cabin. In fact, looking at it you might wonder if it was much more than the base for a mammoth

chimney. But the tall structure rising from its roof is not really a chimney at all. It is a means of entrance when the snow is too deep for the workers to enter on the ground floor. A ladder goes all the way up one side. The patrolman crawls up, crawls through the small doorway and then crawls down again through the inside of the chimneylike structure to reach the interior of the cabin proper.

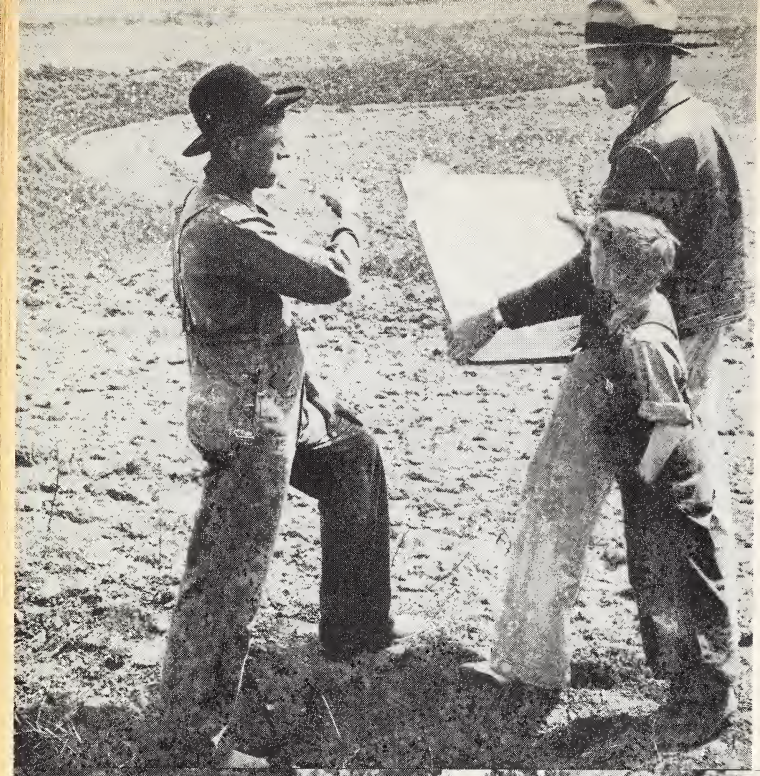
Protection of the watersheds is a part of the job in the forestry service too. Watersheds are forests, grasses or brush which cover mountain ranges and other large areas of the country. They play their role in influencing the regularity of water supply.

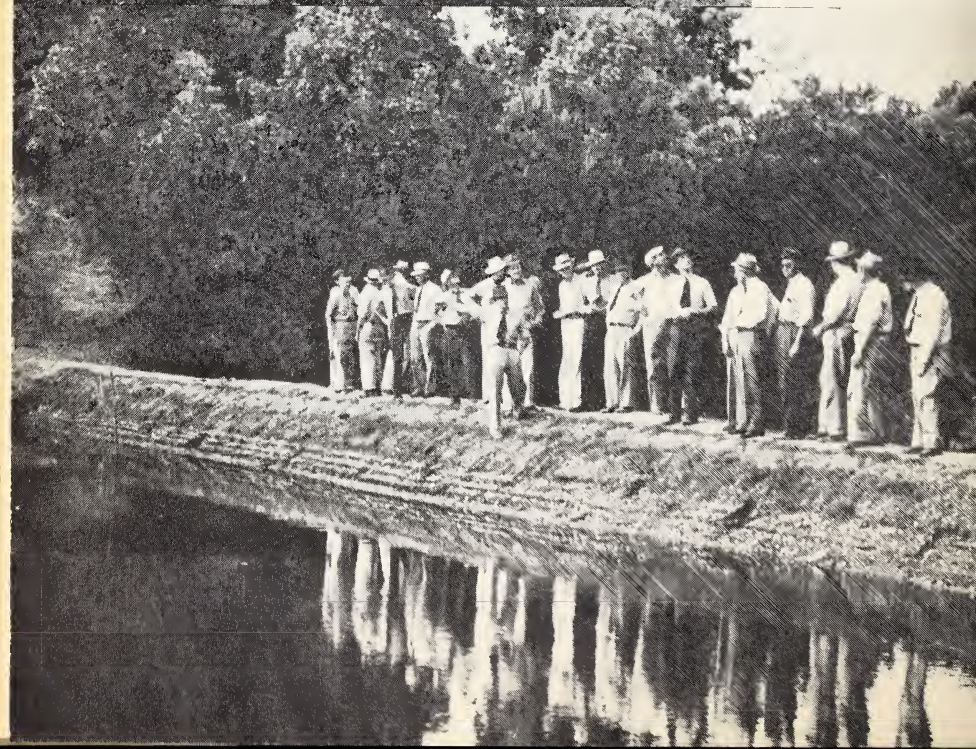
The forest ranger, the junior range conservationist and other active men in the field supervise the use of the range land in the National Parks, ranges where cattlemen and sheep raisers can graze their stock.

Trees, water and soil—all these are bound up with the work of the trained forester. Farmer, rancher and businessman welcome his services, for any friend of the forests is their frend too. If they have not already met up with this loyal worker of the country's welfare, it is time they did, for their own interests and those of the Forest Service.



An earth dam and reservoir for storage of run-off water to be used for irrigation. Trees, too, are natural dams, for they hinder the flow of running water and hold the soil in place. The Soil Conservation Service and the Forest Service are separate units, but by protecting the forests the ranger also protects the soil.







Above: Forests alone cannot prevent floods, but they do make a tremendously important contribution to the cause. That is why rangers and an agricultural engineer like this man here work hand in hand. In this picture, farmers are being taught how to use their land in order to prevent the soil's washing away through gullies.

Upper left: On millions of acres, trees are nature's most faithful protectors of the soil, whether it is farmland like this, or steep slopes and ravines. They help build up its fertility and prevent dust-bowl conditions. Here a conservationist helps a farmer in planning the type and amount of crops he should plant on his land.

Lower left: From forests to fish is a short step, for forests have a great influence on the size, shape and direction of streams in which bass and trout may find their homes. Thus the rangers precede the Fish and Wildlife Service. Here, a representative of the latter is reviewing the work done in the creation of this farmer-built fish pond which has been stocked with bass.



Left: Trees help in soil fertilit by protecting the ground fron the baking-out and drying factor in too much sun and wind. Thi conservationist is making a farn map.

Below: Forests are like walls pro tecting regions from winter blast and the hot summer winds. Her a conservation specialist explain the resources of soil to a grou of pupils on a school excursion



CHAPTER IX

BRING 'EM BACK ALIVE

THE big, shaggy head lowered. Sunlight glinted on the crescent-shaped horns. Under the stamping, sharp hoofs the dust rolled. The small eyes glared defiance. But for all the old bison's strength and size, his defiance was futile in the face of the Indian horseman galloping toward him. Without slowing his steed, the Indian sighted along his gun. There was a flat roar, a puff of smoke, and the brown leader of a diminishing herd fell to the earth, the small eyes glazing in death. Behind him the rest of the herd tried either to stampede or escape, but there was no use. Other Indians were galloping forward. There was more gunsmoke—and more dead bison. Yelling triumphantly, the Indians emptied their guns. When their ammunition was gone, they could get more. Where? From the federal government!

Yes, our own government was at one time instrumental in bringing to near-extinction the vast herds of American bison, or buffalo, that at one time roamed the continent in numbers of 75,000,000 or more. In the interests of

settling the Great Plains region, ammunition was given to the Indians and early settlers alike.

Today it is a different story. Through forest and conservation agencies, wildlife that is beneficial to trees and men is being protected by bag limits, hunting seasons, and good breeding conditions. Two hundred and sixty-four wildlife refuges covering over 13,000,000 acres are administered by the Fish and Wildlife Service. The National Forests managed by the Forest Service contain nearly 30,000,000 acres of state and federal game refuges. If you like wild animals, you don't have to go to India or Africa to study them. There is plenty of big and small game right here at home. Deer, bighorn sheep, antelope, moose, caribou and bear—these are only some of the 5,000,000 big game animals in the United States. More than a third of them are in the National Forests.

It is part of the forester's tradition to guard the welfare of wildlife. Most of the animals depend largely upon the forest for their livelihood. The same is true of birds. Many of them live in the open, but the majority prefer the woods. When trees go, the great groups of wildlife go with them. More than once, foresters have rescued animals from death at the risk of their own lives. Because they are men of the forest, they understand and know the creatures that inhabit it and do all they can to protect them.

Perhaps you wonder how that can be so, when the forester's main purpose is to give the nation a constant

wood supply, and consequently he must be busy felling trees. For do not cutting operations rob wild animals of their homes and leave them without a refuge?

It is largely the other way around. There is more than enough evidence to prove that game animals actually multiply where forestry is practiced. The forests of Germany have been cut over and over again for hundreds of years and yet there are more deer there than ever before. Deer and elk often tag after cutting operations instead of fleeing, for they find it easier to get food on such land. The important thing is just that—food. With hunting and trapping regulations, wildlife always increases as fast as its food supply permits. If half of the food is taken away, half of the wildlife perishes. So, actually, the cutting of forests by practical methods is to the benefit of wildlife. Sunlight is let into the otherwise dark aisles and the growth of young seedlings and plants on which animals feed is promoted.

Fire is not only the enemy of the trees, but of wildlife too. Since the first duty of the intrepid young men in green—whether they are serving the federal government, the state or private owner—is to stop forest fires, obviously they are saving the forest's furred and feathered population at the same time.

The living creatures of the wood flee in terror before the sweeping flames. Birds' nests make quick fuel for the blaze. Many animals are trapped by the fire. The lucky ones make a wild exodus before their most fearful foe. Every year the forester finds evidence of disasters—

the charred birds' eggs, the burned remains of antelope and elk in the haunts where they tried to run for shelter, thousands of blackened carcasses of squirrels and deer. The greatest loss of all is in the destruction of eggs and the young, and in the ruin of their coverts and hiding places. Foresters are determined in their struggle to end such tragedies. Today, more than a thousand federal forest officers are doing work, without compensation, as deputy State Wardens. Because of their generous spirit and enthusiastic interest in this side of the job of forestry, game is increasing in the National Forests.

Protection of wild animals is not new. Back in the days when hunting was the luxury of kings and nobles, tracts of timber in Europe were put aside from public use. There the deer, boar, elk and other game were protected from all but the arrows and spears of the nobility. The foresters of those days were the officers of the king, and it was their duty to protect the trees so that the forests would remain natural refuges. Today, the foresters of the federal and state governments are the officers of the people.

As an example of wildlife study, the work of the New York State College of Forestry gives a good picture of the kind of duties such an officer may perform. This work is being done on a more specialized plane than a forest ranger's, but it illustrates the objectives and general pattern of the work as a whole. Actual forest rangers, as well as students, work at the big experiment station

in the wilderness of the Adirondacks. Professor King is the man who directs the activities among the group studying the 5,000 acres which is one of the most interesting wildlife research centers in the United States.

The most important project which the group undertakes each month is a census of the wild game in its territory. By automobile or train, the group sets out from Syracuse for the big dormitory in the Huntington Forest. There the young forester unpacks his bags, fixes up his bunk, and gets his instructions along with the rest. Everyone is eager to get to work and they are all dressed for the part. The ranger has on his trim green uniform. The students wear boots and breeches and bright plaid shirts. Mimeographed maps are handed out, showing the route which they will follow the next day. They are ready for their first trip.

Morning comes, and it's time to be up and on the way to see what the grouse and deer are about. Outside, the trucks warm up their motors and the sound fills the cool air with a steady humming roar. The forester has a hearty breakfast with the rest and they leave at seven sharp.

He climbs into the truck he has been assigned to, his lunch under his arm, a notebook in his pocket, and a watch somewhere on his person. As the truck rumbles into action, he sits back and watches the wilderness glide by until the driver stops at the proper destination. Now for action.

The forester and his group start out along the "check" lines, the paths that have been mapped out by previous surveying of the property. His notebook is out and his pencil ready. For a moment he doesn't see anything but the dusky columns of the trees. There goes a porcupine lumbering through the brush. The forester doesn't have any great love for that particular animal, for it is too fond of eating the bark off the trees, but he makes a record of the quill-bearing creature. His pencil moves over the page quickly: 1 porcupine.

The group moves on. The forester's head jerks up. What is that faint drumming noise? A woodpecker, and he is working away at his carpentry on a big tree to the right of the trail. The forester's pencil moves again.

That's the way it goes. Whatever animal or bird crosses the path, down goes its name in his book.

Wait a minute! What kind of animal is that just ahead? It's a squirrel all right, but it certainly is not like the squirrels you see in city parks or in the country. This chipper fellow is bright blue! But the forester doesn't even look surprised. It is part of his job to look for animals with color schemes that they never inherited from nature: deer with rumps striped in vivid red or yellow; porcupines and beavers with glittering earrings; ruffled grouse that look like flying rainbows with their tail feathers of crimson or green or orange. The forester himself has had a hand in decorating such wildlife for the purpose of identification.

The forester has been a member of a group studying a deer which was kept in captivity under a scientific feeding regime. After sufficient study, it was decided to put the deer back in its natural habitat in order to carry on the experiment. So the forester and a fellow worker daubed some paint on the animal in order that it could be spotted later whenever it was encountered in the forest. They repeated the process with all the other captive animals being studied.

A question such a forester is often asked is, does the painting of the deer bother them or injure them? Does a deer, for instance, have an inferiority complex when it goes back to the herd with a rump the color of the Russian flag?

"Not in the least," the forester answers. "The deer is likely to develop into a snob and act as vain as a peacock. Why shouldn't he? Compared to the drab coloring of the rest of the bunch, he's a shining light. The does flock around him so that he never has to worry about being a forgotten member of the stag line. The same thing goes for birds. They're great lovers of color, anyway, but some species, such as the brown ruffled grouse, can't boast of much brilliance—until we paint their tail feathers. Then you should see them strut."

"How about earrings and tags?" people sometimes ask. "Don't they hurt the animal?"

"No. We put metal tags on the ears of deer and it's neither frightening nor painful. In fact, lots of them

come back into our traps deliberately, over and over again, to get a taste of the bait we put out for them."

The traps the students and foresters use in this work are the most humane possible. The traps in the Huntington experiment are ingenious types devised by Dr. Vernon Bailey, former chief naturalist of the U. S. Biological Survey. The deer traps are big, doubled-ended boxes equipped with triggers which are baited with tasty twigs or apples. When the deer nibbles at the bait for a snack, down go the drop doors at both ends, and there he is.

A device which Professor King calls an "exclosure" is also used. It is a pen made to keep animals out! The reason for this is the need to study certain kinds of plant life under protected conditions, where hungry and trampling animals cannot reach them. One pen may exclude deer. Another may be made of mesh which is fine enough to bar rabbits and other creatures of similar size. Some will even be screened and roofed to keep birds away.

The forestry and wildlife students have found out that deer often defeat their own purposes by devouring berry bushes, young balsam, and other bushes and saplings before they have a good start in life. As a result of such discoveries, Professor King says that true conservation means that dense woods will have to be opened up by selective cutting and clearing in order to let in sunlight and rain which will aid the bushes and plants

in growing. This is still more evidence that cutting trees is conducive to wildlife welfare rather than destructive. Deep woods must be kept for hiding places for the animals. On the other hand, open spaces are also essential.

As the forester continues on the trail with the research group, he keeps his eyes out for trees with orange bands painted on their trunks. Such trees indicate the course he is to take. There are orange signs, too, to guide him.

If the weather is good, his trip will take about three or four hours. In winter he travels on snowshoes and the time spent in checking the trail may be a good deal longer. Either way, it is exciting work, done in an inspiring and healthful setting. When the day is over he can climb into his bunk with the satisfied feeling that he has contributed his bit to the management of wildlife through forestry.

What the Forest Service does for wildlife means much to our entire population, and to sportsmen particularly. Sportsmen spend an average of $150,000,000 a year in the pursuit of game. In many states the value obtained from fur and food alone is as much as a million dollars a year. The protection of game birds means a good deal to the farmers too, for the birds eat up weed seeds and destructive insect pests.

There are definite tracts of land that have been set aside in the National and State forests where game may live in well-protected security. There are bird refuges

which serve as sanctuaries for birds in their migrations. These places are wildlife museums, too, for the animals become quite tame and even enjoy human companionship.

The forester is not a friend to all animals indiscriminately. Bobcats, coyotes, lynx and mountain lion prey on more valuable species and kill them in greater numbers than lawless hunters do. So if the forester gets a chance to draw the bead on one of these villains, he does not hesitate. Bullsnakes destroy thousands of wild-duck eggs. Skunks, crows, magpies and wolves are on the enemy list too. Those are the animals that the foresters and the game agents *won't* bring back alive.

Game can sometimes be a nuisance too. An agent for the State Game Bureau was making a field trip one day when he saw large numbers of white-necked ravens circling around the telephone poles that run along the country road. He made a mental note of it. A few days afterward the telephone company called, complaining that there was trouble on their lines. They wanted to know if the agent could help them solve the mystery. Armed with traps, he went back to the telephone poles where he had seen the ravens. What had happened was that the ravens had used bits of fencing wire in building their nests on top of the poles and had caused short circuits.

Farmers, too, often have complaints to make about certain destructive activities going on around their farms.

As a rule, beavers are helpful animals but sometimes they put their teeth to work in the wrong place and construct dams that flood valuable fields. In this case, state game agents usually have a job of "nuisance trapping" on their agenda.

Colorado decided to put her furry engineers, the beavers, to work, and did, with the result that the whole state benefited. From twenty-five to fifty years ago, Colorado's beaver resource was practically exhausted. Now, since the advent of game management, the Forest Service estimates that there are nearly 50,000 beavers in Colorado in the streams of the National Forests, that being about half the number in the entire state.

With such a population of beaver, someone figured out that they could be put to work in a good cause. Dams were needed in the high-water basins. Beavers were the answer. The industrious builders could be taken away from the streams bordering pasture lands and highways and put in headwater streams at higher elevations where little damage could be done—and, more important, where much good could be done.

Instead of laying out a large amount of money for man-made dams, the work was put onto the glossy shoulders of beavers. Trucks rumbled up the mountains, bearing their loads of bewildered little animals, and then unloaded them in the prescribed places. It didn't take the beavers long to get to work. They kept their teeth sharp on the trees, and made one dam after another.

The fact that a colony averaging four to eight beavers will build one master dam and a series of supplementary catch basins above and below the main structure—as many as twenty dams in such a series—speaks for itself. The water at the stream heads is retained where it can be released in regulated flow to provide irrigation and prevent flood. The beaver dams not only hold back spring run-off, but they catch silt that would otherwise be carried into reservoirs and canals. Trout fishermen, too, are benefited in the Rockies, for the dams keep back decaying vegetable matter which otherwise might pollute the water and kill off many of the fish. This work with the beavers is typical of the Wildlife and Fish Service.

One important milestone in wildlife conservation on the part of our government was in 1913, when the Migratory Bird Law was enacted. This was extended on a bigger scale in 1918 when the Migratory Bird Treaty Act between Great Britain and the United States was ratified. In 1936 the Act was amended to extend its provisions to Mexico.

More closely related to the work of the forest ranger are the efforts that have been made to create large territories suitable for moose habitats. The area between the Red Lakes and Lake of the Woods in Minnesota is an example of the close connection between forests and wildlife. Homesteaders and squatters have been forced to move so that the land can be developed for wildlife production. One of the most outstanding features is that

of fire protection through the building of over 250 small timber dams that have saturated great areas of bog and marsh lands. By eliminating the settlers, controlling lumber operations and plugging the ditch systems, this experiment has been very successful.

What about wildlife and war? That is not as irrelevant a question as it might seem at first glance. Not if you realize that in 1941 the Army took over a million acres of national wildlife refuge land for military purposes. But what happens to wildlife when tanks grind, skid and slash through forests and underbrush; when artillery and anti-aircraft guns spew their smoke and thunder through the air; when thundering airplanes unload their bombs and rip at ground targets with their machine guns? What effect does that have on the refuges where waterfowl and upland game birds, deer, bighorn sheep and antelope, come to rest, feed and rear their young?

The answer to that question can come only from refuge managers and wardens, men who are close to the scene. They report that the wildlife lands used for military purposes are not devastated, and wildlife is not destroyed or driven out or even seriously disturbed except in isolated instances. In fact, they say that in some areas the military activities actually give a measure of wildlife protection due to the exclusion of civilian activities!

National Forest lands turned over to the War Department are now in excess of a million acres. In the case of wildlife refuges, the lands chosen were largely in the

Western States. In no instance have highly developed wildlife areas been turned over for war purposes.

The forest ranger knows that his greatest contribution to wildlife conservation is in making the forest home of the animals a secure and productive one. He knows, too, that just as timber is a forest product, so is game. The young men in the forest service play many rôles, and the part they perform in helping to preserve our birds and wild game is one more act in the drama of forestry.

The Wildlife and Fish Service is a separate branch of the Department of Agriculture. It, too, offers a growing field of employment. Recent trends in education show that it is taking its place as a profession along with forestry, engineering, law, medicine and the other recognized fields. As a result, many colleges and universities offer specialized courses that may be regarded as fitting into a wildlife-management curriculum. Although such courses are helpful and often basic, few institutions are yet offering a full four-year course in the management of wildlife, leading to a degree.

But there is a demand for specialists who understand the diseases of wild animals and their cures, who know about game and fur-animal production, or who are qualified to do educational work in the relationships of wildlife to agriculture, to forestry and to other land uses. In the research field, workers are wanted who are trained in the distribution and taxonomy of birds, mammals and other vertebrates, and in the sciences concerning fish.

If you are interested in the research phase of this work, you will have to have preparation along the following lines: In the field of mammal and bird toxonomy it is essential that you should be well-grounded in general biology, zoology, anatomy, genetics, museum technique, histology, and aquatic and marine biology. In research connected with food habits, you will need a varied training in order to identify in animal stomachs fragments of seeds, insects and other food. Also, you will need knowledge and skill in laboratory technique. The physiology, nutrition and hormone fields are open for advanced research on the health and vitality of important wildlife groups.

Research in the life history and habits of bird and mammal species means that you should be familar with a wide range of animal and plant identifications. You will have to have a knowledge of forestry, agricultural crops and soils; of breeding, feeding and nesting habits. Of equal importance will be your ability to recognize and interpret facts in their proper setting and perspective.

If you are to be a laboratory or field worker in the prevention, arresting and cure of animal maladies you must have a thorough knowledge of laboratory technique, thorough training in diagnosis, and familiarity with the identification of endemic diseases, parasites, tumors and the like.

Fur and game farms and wildlife experiment stations require personnel trained in wildlife production. In this

service, you should be familiar with the principles of breeding, feeding and management, as well as of diseases and their control.

Or perhaps you prefer to go into the administrative end of wildlife—the field of game management and the protection of favored species. You must be familiar with wildlife in respect to its habits, habitats and ranges. Since law enforcement will be part of your job, you should have a working knowledge of federal and state protective laws and regulations. It is vital that you be familiar with the habits of all the major species of wildlife in the area under your jurisdiction, and that you have a knowledge of the control technique of injurious types, with experience in field application, along with the ability to recognize wildlife values from esthetic and recreational angles.

It may be that you will choose to be a field worker dealing with wildlife in relation to forestry, soil conservation, flood control and all the other phases of forest, farm and aquatic-wildlife relationships. In that case you will need to possess a broad technical knowledge to interpret and apply known facts of basic science, some training in business administration, an understanding of silvicultural methods, forest administration and some engineering training. In other words, you must be able to fit wildlife into the multiple land-use picture.

Migratory-bird refuge administration requires personnel with specialized knowledge as well. Among other



This ranger is making a survey of the deer in Malheur National Forest, Oregon. Our national government has put a lot of effort into the preservation of deer, the most sought-after game animal in this country. Thanks to game laws and restrictions, there are now more deer in many areas than there probably were at the time of Columbus.





Above: These little animals are not going to market or to the zoo. They are beavers—the furry engineers whose work as dam builders is so valuable. The foresters are taking some of them away by truck for transplanting in another forest area where their dams will help to hold spring flood waters in check.

Left: The ducks in these two pictures are being tagged with loose-fitting bands which carry numbers and the invitation, "Notify Washington," which means if a hunter bags one of these he should contact the Fish and Wildlife Service, U. S. Department of the Interior, Washington, D. C. The bands are used for purposes of identification in studying the migratory habits of waterfowl.



Above: An elk refuge in Wyoming. It is part of the forester's tradition to guard over the welfare of wildlife, though the specialized work of this kind is done by the Fish and Wildlife Service. Special game refuges and reservations have been set up for the protection and study of such animals as these.

Below: The forest ranger knows that his greatest contribution to wildlife conservation is to make the forest home of wild animals secure and productive. In this picture technicians are inspecting a litter of pups from an experiment in breeding a silver with a red fox.





Above: Epidemic diseases that sometimes attack flocks of birds must be watched for and fought against. These game wardens hold a carrying case to transport sick birds.

Below: Another enemy of wildlife has been caught—a hunter who violated the United States Fish and Wildlife game laws.





Above: The Wildlife Service keeps up with the times. Here is a plane used in patrolling remote areas that are too difficult to reach by other means of transportation.

Below: This neat modern house is the home of the manager on Sand Lake National Wildlife Refuge, South Dakota.



things, you should be well acquainted with the life histories and habitats of waterfowl, fur animals and upland birds; with aquatic vegetation suitable for food, cover and nesting sites, and technique in improving food and cover; and with desirable water levels and their engineering phases. In order to be a refuge manager, you must be informed on protective laws and regulations, and trained in business administration and in handling personnel and equipment.

"Bring 'em back alive" and keep them that way—such is your goal in the wildlife services, whether it's beaver, Chinese pheasants or the shaggy buffalo.

CHAPTER X

FISH ARE FUNNY

THE whine of a reel cuts through the sultry air. A faint spray of water flies back in the fisherman's face as the line spins out. There is a liquid "plop" when the plug strikes the lake's surface.

"I'll bet you get another strike near those weeds!" the man's companion at the other end of the boat says hopefully.

Smoothly the fisherman winds in his line. There is a sudden quick jolt at the end of the silk. He grins and jerks his pole slightly to the side to make sure that the hook is snagged securely in the fish's mouth. For there is no doubt that it is a fish, and a heavy one too! It's going to be a battle to land it in the boat. The man keeps his line tight. The reel turns hard. Slowly the fish is hauled near the boat. The two men can see it now. It's a pike, big and shimmering, struggling mightily against the hook.

"A twenty-pounder, or I miss my guess!" the man with the rod pants as the other pushes a gaff hook under

the captive's gills and hauls it over the side. "Say, we'd better quit. We've got one over our limit now."

"Quit? When we're having luck like this?" the other looks around searchingly. "There isn't a game warden within a hundred miles of here!"

"Guess you're right," his companion answers.

But the men have a surprise in store, for the deputy game warden is always on the job, and the fishermen will not be very happy when they hear his motorboat purring around the corner of the lake. They have violated the state's fishing laws and they will have to forfeit their equipment or pay a specified fine, or both.

Fresh-water fish limits are regulated by state law; and in each state game wardens see to it that they are put into effect. These state Departments of Conservation work hand in hand with the federal conservation organizations, especially the Wildlife and Fish Service which was established on June 30, 1940, consolidating the work of the Bureau of Fisheries and the Bureau of Biological Survey. The lines of work of these formerly separate bureaus are, with a few exceptions, continued under the new agency as functions of the original divisions. Most of the field operations other than research are carried on in all the states through a regional organization, with five regional directors in charge.

Let's take a typical state—Minnesota—and see just what kind of work is carried on by the Division of Game and Fish. Men who become game wardens must pass

a Civil Service examination. In one year in Minnesota, 1600 applicants took the examination and 250 were certified on the eligible list. In order to improve the warden service, a three-day game warden school was held in St. Paul and special training was given so that the wardens would have a better knowledge of the fish and game life throughout the state. The state is divided into eighteen districts, with a warden supervisor in each. The supervisors were selected from the eligible list of game wardens.

These wardens have a big and varied job on their hands, for Minnesota is the land of Ten Thousand Lakes, and that means a lot of fish, to say nothing of game and birdlife. Aside from being kept busy at enforcing game and fish laws, the wardens may help construct timber dams, supervise work done by native American Indians in the wild rice fields, help transport fish from one spot to another, make reports and give talks to local sportsmen's organizations, and work hand in hand with trained technicians doing conservation work.

What kind of trained specialists work directly with fish? Scientists who are able to make adequate investigations of commercial fisheries, manage or work in hatcheries, recognize and cure certain fish diseases, and understand in general the whole problem of preserving and propagating more fish.

One of the big problems in any state is that of keeping a healthy supply of fish in the streams, rivers and

lakes. Suppose the state wants to stock a stream with legal trout for the rod. Hatcheries must be constructed and the fish raised artificially.

You hear a good deal about vitamins, carbohydrates and proteins these days. Diet is important to fish, too, and the men in the hatcheries have to know how to make the food supply the best for the type of fish being raised. A good example of the kind of work done is that of the Cortland Experimental Hatchery in New York State.

Fish dieticians at Cortland have found that a very good food consists of twenty-four pounds each of dried skim milk, cottonseed meal, whitefish meal and wheat flour middlings, and four pounds of salt. That may not sound good to you, but the fish thrive on it. The mixture is prepared in large quantities and stored away in barrels or bins. Equal weights of this dry feed mixture and ground frozen pig spleen are mixed together with a small amount of water. This mush stands over night and at feeding time is then fed, by means of potato ricers, to the fish in troughs.

Such dietary experiments as this help the technicians to note the effect of various foods on egg production, the length of life and the weight and length of the fish experimented upon.

In order to see what happens to hatchery fish when they are sent out into the world on their own there has to be a way to tell them from the others. One way is

to put tags on them, little celluloid tags which make it possible for the scientist to recapture the fish and study its growth over its period of freedom. It helps him also to make egg counts; this is in order to predict the possible egg production of a run.

More spectacular than tagging is the experiment which uses artificial coloring of the fish. It has been found that powdered madder root can be fed to rainbow trout and that it stains the bones of the head, vertebral column and fins, thus giving to the fish a rosy glow.

The work in hatcheries sometimes causes diseases in fish because of the unnatural conditions. From time to time epidemics have killed off the stock. The only fish diseases that are even partially controllable are those caused by external parasites.

Diseases caused by unknown sources are called "environmental" diseases. These often come about, in hatcheries and in natural habitats, by a change in the water in which the fish lives. Forest fires or drought may be the cause, especially if the lake or stream is low. Chemical treatment of the water supply has been used with varying degrees of success.

One problem that must be met in the whole process of planting fish in specified streams and lakes is that of transportation. The states are doing a good job. The answer has been found in steel tanks to which an oxygen supply is connected as an aid to keeping the fish well during the period of delivery by truck.

Perhaps the most interesting experiment ever made in the transportation and re-allocation of fish was the project of carrying thousands of giant salmon from the Columbia River to the auxiliary streams of the Wenatchee River and Icicle Creek. The unusual job was ordered by the U. S. Bureau of Reclamation to save a $15,000,000-a-year salmon industry.

Up the Columbia River each year moves the greatest salmon run in the world, the Chinook and Steelhead, bound for the headwaters to spawn and start a new generation. The parent fish die but the salmon young go down to the ocean to grow. Five years later they retrace their way upstream to their own native waters. With the construction of the Bonneville and Coulee Dams, the path of the salmon was blocked.

At the site of the Bonneville Dam, 150 miles from the mouth of the river, expensive fish-ladders were built to enable the salmon to get past. However, the most intricate fishways in the world could not conceivably get the salmon over the immense height of Grand Coulee. The only answer was to hire specially constructed trucks to collect the fish and carry them to other, unblocked tributaries above the great dam.

The fish traveled in lots of thirty to fifty at a time in a thousand gallons of Columbia River water, constantly aerated to supply the salmon with enough oxygen. The tanks were protected by insulation against outside temperatures ranging anywhere from 30 to 108

degrees. In transit, the salmon compartment was gradually cooled to prepare the fish for the chill tributary waters.

Airplanes have an increasingly important rôle to play in the planting and protection of fish. California, for instance, has a regular "fish patrol," in which the Division of Fish and Game works in collaboration with the Coast Guard.

Warden Greer and his coast-guard pilot may be flying on patrol over San Pedro harbor. Suddenly the warden sees a fan of oil spreading out over the water in the wake of a freighter below. He taps the pilot on the shoulder and tells him to circle down over the ship. At five hundred feet, the fish-and-game warden aims his camera at the ship and the streak of oil. He trips the shutter. He checks the name of the freighter and switches on a two-way radio. He contacts a surface patrol boat and delivers his message. "Get a sample of the evidence. I just took the picture!"

The charge is "ocean pollution" when the captain of the freighter is hauled into court a few days later, for the law forbids the pumping of ballast, bilge water or oil, or the dumping of garbage within a twelve-mile limit.

The chief purpose of such a patrol is to watch out for law breakers and arrest them. Another is spotting schools of fish or bait from the air. Their location and size are recorded in the daily log made out each day by

the flying warden. This information is available to fishermen and is used in research work.

Airplanes have proved to be the best solution to restocking mountain lakes with fish. Thousands of high mountain lakes offer ideal potential fishing to anglers—but they don't have in their waters any native trout or other game fish!

Montana has been a pioneer in this field. In the fall of 1938, members of the Montana Fish and Game Commission rowed out on a small lake near the Billings airport. A sportsman pilot and fishing fan, Herman Hendrickson, loaded a can of fish into his plane, flew over the lake at low altitude and ladled out the fish and water with a dipper. The tiny trout went sailing downward to splash into the lake. They weren't even stunned.

With such a promising beginning, it was decided that the experiment should be carried further. A Stearman biplane was fitted out with a fifty-gallon tank built into the front cockpit. In the bottom was fitted a manual-operated dump valve six inches in diameter. The pilot could operate this from his cockpit. The spilling of fish and water in rough air was prevented by a hinged metal cover. Aeration of the water was done by means of a half-inch copper tube which led to the tank from a funnel set up on a strut. In that way the water was kept well activated by air under pressure.

The trout were dropped from low altitudes into a minimum water depth of three feet. The experiment of

restocking lakes in this fashion was highly successful, and the method is one which is being used more and more frequently both by State Fish and Game Commissions and their federal counterparts.

What about that great fishing country to the north—Alaska?

It is spring. The shipyards of Seattle hum with activity. The sturdy boats, the rugged men lining the rails, all are symbolic of just one thing—salmon. For each spring the boats are brought out from their winter moorings and fitted into shape for the seven months of adventurous work ahead of them along the coast of Alaska. Seattle is the departure point and the last contact the fishermen will have with the States until they return in the fall.

During the summer fishing season at the Alaskan canneries, the salmon are caught in red hordes from early in the morning until dusk, thousands of them. The men bring them in scow loads from the traps, fifteen to forty thousand fish to the scow. Tenders load the holds of their ships until the after deck is awash. Because of federal regulations, not all types of work are carried on at each cannery. Fishing in Bristol Bay north of the Aleutian Islands and off Alaska's coast, is limited to double-ended, two-man boats driven by sail, and to beach nets extending out into the river. In southeastern Alaska trap fishing and motor-powered fishing boats are allowed.

In 1940, salmon products represented 81 per cent

of the weight and 91 per cent of the total value of Alaska fishery products. It is no wonder that special efforts are made to protect these valuable fish. Such efforts must be increased in wartime. Control over the fishery resources is necessary to prevent unwise exploitation in a period of national emergency when current market demands stimulate increased operations.

Workers in fishery protective work in Alaska include fishery-management agents, stream guards, weir operators, vessel crews, and biologists. Through the salmon season, careful observations must be made so that the extent and condition of the salmon runs and escapements can be studied in order to modify fishing regulations as the need arises. Obstructions must be removed from streams that block the passage of the salmon to their spawning grounds. In wartime, many of the Alaska fisheries have been forced to shut down in order to prevent too severe a drain on the small salmon runs expected. Severe restrictions have been put on herring fishing as well.

In the big field of wildlife management, the federal government needs an efficient personnel. One type of worker is the United States game management agent. Doing similar work are the deputy United States game management agents and the deputy United States game wardens.

Anyone looking toward a career in game management should be at least a high-school graduate. Your health

and character should be good and the prospect of playing a rôle in the big job of conservation should be one that appeals to you. Your chances of getting an appointment after you have passed a Civil Service examination will be much greater if you have a background of training or practical experience in the sciences of agriculture, zoology, the study of fish, law, and even public speaking. The game management agent is primarily a law-enforcement officer. Some of the occupations that will help you get outside experience are those of being a caretaker for a hunting or fishing club, a guide, a worker on a private wildlife refuge or game farm, or even a laborer or patrolman on a federal, state, or private wildlife refuge.

The government maintains numerous research laboratories and biological stations as well as fish cultural centers. In order to qualify for temporary appointments in the specialized fields of work, you will need certain basic training. If you want to be a Junior Aquatic Biologist, for instance, you will need a bachelor's degree from a college or university of recognized standing showing that you have majored in some branch of biology. Your entrance salary will be $2,000 per year. Other positions and qualifications are as follows:

Assistant Aquatic Biologist: In addition to the preliminary requirements for the junior professional grade, you should have had at least two years of subsequent experience of a practical or professional nature. One year of graduate work in biology may be substituted for

one of the two years of required experience. Entrance salary is $2,600.

Associate Aquatic Biologist: Along with the requirements for the junior grade, you must have had at least three years' experience. You may substitute one or more years of post-graduate work for each year of required experience, but in order to qualify entirely on the basis of academic work, you must have a doctor's degree. Entrance salary is $3,200.

Full Aquatic Biologist: To get this job you have to meet the preliminary requirements of the junior grade and show that you have had at least three years' practical and professional experience after graduation. Here you will have a chance to do highly specialized, independent, investigative work, and in addition, administration. Entrance salary is $3,800.

These positions are obtained through Civil Service examinations. Higher positions, such as Senior, Principal, Head, and Chief Aquatic Biologist are usually filled by promotion.

If college training is impossible for you, there is still a field for you in this work. You can work as a Junior Biological Aid, doing simple, routine tasks of a general nature. You must be a high school graduate with credits in biology. While learning the field and getting experience, you will at the same time be earning an entrance salary of about $1,500.

Fish, forestry and wildlife—all are a part of the chal-

lenging service of conservation. Fish, like the other forms of life associated with the forest, are a great economic asset to our nation as well as a source of recreation.

The rangers in the National Forests, the guides in the National Parks, the men and women in scientific research, and the state game agents and commissioners—all are contributing to making our land richer and happier. The fish stories told by these workers are not about the big ones that got away, but about the bigger and better fish that are being propagated and protected—whether they are fish swarming in the troughs of the hatcheries or fighting at the end of an angler's hook.

CHAPTER XI

THE MAN AT THE TOP

THE head of the men in green, the general of the battalion of forest rangers, guards, conservationists, and all the others is the Forest Supervisor, the top man in a National Forest. If you enter the forest service and give your best to the job, you may be in his place some day.

How would you like living in the midst of one of our National Forests with trees and sky all around you, supervisor of all you can see from horizon to horizon? Or your headquarters might be in an office in a near-by city. In either case, your duties would be the same, and they are important and exciting duties bound up with all the things that go to make a National Forest a living example of what modern forestry can do. It's a job to be proud of, and it's well worth the work and years that go into preparing you for such a high post.

You'll need a good head for business and all-round administration and a constant devotion to the forests, even though you will have left the fire-fighting and active field work to men lower in the service. Though

the intimate work with trees and wildlife is behind you, you will remember all that experience in such work has taught you. It will help you take care of the new responsibilities that are yours.

The job of the forest supervisor is a synthesis of all the phases of forestry rolled up into one, under the title of forest management. In other words, he is the big boss in command of a million or more acres of federal forest land. It's up him to see that the forest is a going concern, just as though he were at the head of a private industry and had to show a continual profit to keep the job.

The profit here isn't figured in dollars and cents so much as it is in the welfare and progress of the forest as a whole—timber, range, water, game, and so forth. The supervisor is not trying to make a lot of money when he arranges to sell big tracts of timber to private purchasers. He sells only when the forest benefits by the removal of mature trees.

Suppose that in a section of the forest under his control there is startling evidence of erosion as the result of a recent fire. Something must be done and done quickly. The supervisor is a man of action, for he has not forgotten the days when he was a ranger. He may instruct his assistant supervisor to see to it that so many acres of mustard seed are planted to develop a temporary vegetative cover. Before trees can be set growing in the soil, the small mustard plants help keep the soil from blowing and draining away.

Or he may advise one of his district rangers to under-

Scientists in the Wildlife Service. Because of the diminishing supply of wild animal pelts and the growing demand for fur, the Service is directing its research facilities toward improving furs of animals raised in captivity.

Below: A technician preparing tissues for microscopic study for evidence of disease in game birds.



Concentrations of snow geese in the Sacramento National Wildlife Refuge. By providing these places of refuge, and enforcing game laws, the national and state governments have kept the birds from becoming extinct.



Dr. Clarence Cottam of the Fish and Wildlife Service examines bird stomachs. By discovering what various birds eat, he can determine how much they help the farmer in destroying insect pests. *Below:* What a blackbird had for dinner.





Often where there is a shortage of proper food for waterfowl, the Wildlife Service sees that it is provided. These workers are planting wild millet, which is a small-seeded cereal and forage grass.



A little skill with tools is not amiss for the worker in the Wildlife Service. These men are constructing an animal cage for the Patuxent Research Refuge in Maryland.



Above: Wherever fish can swim, planes can fly. This one has just come down on Crooked Lake in Minnesota with a load of small-mouth bass fingerlings for planting. The cans of baby fish are first set into shallow water along the shore in order to equalize the temperature of the water in the cans and lake. Later they will be released.

Below: First call for dinner! This Fish and Wildlife Service worker plays host to trout in a Pennsylvania hatchery.



take gully control—control of eroding soil by building terraces or dams—on a certain section under his jurisdiction. He may have to call in engineers to build check dams or other structures useful in the restraint of erosion.

But because permanent control of erosion is achieved mainly through vegetative covering, his first concern in the normal course of a day's work is with the planting of grasses, vines, shrubs and trees in those areas where he is apprehensive of trouble. Unless he is able to foresee the need for such protective devices early enough, his balance sheet may have all too many red figures at the end of the year.

Foresight means much in the prevention of waste from erosion, for water on the rampage can ruin reservoirs, canals and pipe lines. Cost is a paramount consideration in a well-managed forest. That doesn't mean that the supervisor pinches pennies for their own sake. Instead, he sees to it that the money that is invested is spent wisely.

The duties of his job are determined to a great extent by the type of forest he happens to be supervising. Obviously, his problems are different in a forest in the South than they would be on the Northwest coast. But no matter where he is located, certain fundamentals must always be kept in mind. This is not a hardship; rather it is a privilege.

If you were a farmer raising grain for the market, you would naturally be anxious to get as big and valuable a crop as possible. In the cultivation of a forest, the rangers

and the supervisor desire the same thing—a bumper crop. That involves a real knowledge of timber management, a knowledge of the types of wood, possibilities of disposal, and market trends. The supervisor has been chosen for his job precisely because he does have such knowledge, tested by experience.

If someone asks him, "What are the trends in the use of white pine?" he does not have to go to a book to answer the question. He *knows*. Or if another person asks, "How much must I plant now to meet the needs of seventy-five years in the future?" he can take his pen in hand and figure it out.

Just as a farmer wants to raise not merely one crop but a series of crops year after year, so the supervisor's ambition, too, is to raise repeated crops. Whether he takes over a virgin stand or a cut and burned-over area, his problem remains the same. A burned-over area is not defeat in his eyes—it is a challenge.

If a timber crop of a certain size, quality and value is to be grown, he knows approximately how long it will take. The age to which a crop of trees is allowed to grow before being cut and used is known as the rotation or felling age. Three important factors that determine rotation come under his consideration: 1, the species of the tree; 2, the soil and climate; 3, the method of forest treatment.

He wants to regulate a growing stock so that it will have at all times a proper proportion of young, middle-aged and mature growth. This means that the forest is

capable of producing wood continuously and that it will provide a sustained yield of forest products.

As a result, much of his responsibility is in judging the amount and rate of growth of the timber and working out the best methods of cutting so that he can get a second harvest without having to do extra planting. Where a second crop cannot be obtained by any other method, then he must undertake artificial reforestation.

The forest represents not only lumber, soil protection, and a center for recreational activity; within its spreading acres may exist excellent grazing regions. In that case, the supervisor sees to it that the grazing regions do not lie in idleness when they could be doing someone some good.

This "someone" will probably be farmers, ranchers or livestock and sheep raisers in the vicinity. Ranging land plays an integral part in the production of our nation's meat and wool supply. Not only that, but it furnishes employment to a great number of people. In the West, national forest forage provides feed for some 75 per cent of the West's big game. It gives sustenance for almost 2,000,000 cattle and over 6,000,000 sheep. The owners of these ranches are just as dependent upon this forage as is big game. So, here again, in the wise use of range land, the supervisor is contributing not only to the forests but to the stability of our social and economic structure.

Sometimes he isn't so lucky as to take over any fresh forage land. For any number of reasons—chiefly overstocking the area with too many hungry animal mouths—

the land may have been stripped bare. The supervisor rolls up his sleeves and has his rangers see what can be done about putting the land back into grazing shape again.

We know that the supervisor has a good business head. He has to have one when it comes to carrying out the different kinds of transactions that come to his attention. One of these is the charging of grazing fees.

In 1933 the Secretary of Agriculture approved a plan which provides that "the average national forest grazing fee of 14.5 cents per head per month for cattle and 4.5 cents per head per month for sheep . . . be used as the basic fee, subject to adjustments each year in accord with fluctuations in livestock prices." The total receipts from grazing in the National Forests help to maintain them on a good financial basis.

A general outline of the supervisor's responsibilities in range management is as follows:

1. To restore and maintain a satisfactory growth of subordinate forest vegetation.
2. To determine the class of stock to which the range is best suited.
3. To determine proper seasonal use.
4. To ascertain stock-carrying capacity of the range.
5. To determine the proper distribution of grazing stock so as to reduce damage around natural congregating places, to insure even utilization of grazing

areas, and to protect parts of the range needing special attention.

6. To develop necessary range improvements.
7. To work out and maintain an effective coordination of grazing with watershed protection, timber production and wildlife services.

The supervisor has to settle such questions as the adjustment of use between big game and domestic livestock so that he doesn't deprive the one for the sake of the other. He wants to have fat deer as well as fat sheep. He has to be careful that domestic and wild animals are distributed properly so that he doesn't have grizzly bears and calves treading on each other's toes.

That isn't all. There are many other things—development of water supply; construction of drift and other stock fences; revegetation and cultivation of depleted range; control of rodents, eradication of poisonous plants; control of wayward stock; making of range surveys. Last but not least, the supervisor has to cooperate with stockmen through their local, regional and national associations. The supervisor must be a man who likes people and knows how to handle them. A good deal of the zest of the job lies in meeting all kinds of characters.

Since many of the duties and concerns of the Forest Service are connected with wildlife, the supervisor has charge of such activities too. Chiefly, they are proper protection of the wildlife areas; provision of adequate and

proper food supplies and cover; determination of the proper density of stocking; control of natural enemies (which may include men!); regulation of the public's rights and uses of wildlife.

In the field of recreation, the supervisor serves as an unseen but magnanimous host always considerate of the campers, sportsmen and general vacationists who come to his forest. He is the head of a great national playground dotted with lakes and carved through with brilliant streams where fisherman and swimmer alike may seek their pleasure. Some of his "guests" will be thoroughly appreciative of the recreational opportunities offered them and treat the grounds and facilities with due respect. Others will have to be kept in bounds by the constant supervision and instructions of ranger assistants. For the too venturesome spirits, signs will have to be put up, such as "Don't Feed the Bears." That doesn't mean that some bear-lover won't contribute a few fingers or even a leg to the bear's diet in spite of the warning signs, but it does mean that the supervisor has taken what preventive measures he could.

Thanks to his foresight, vacationists will be grateful to find improved camping grounds provided with fireplaces, tables, drinking water and other conveniences. Athletes will praise the bathhouses, playfields, ski jumps and toboggan areas that often are a part of the supervisor's scheme to make the forest a place of all-round pleasure. To sum it up, a good forest supervisor is also a good host.

In his service he has a group of technical foresters and specialized staff workers. Every worker in the Forest Service is contributing to the forward movement of national forestry, and these helpers are there to go into action whenever the supervisor finds it necessary. He may want to know why so many antelope near the northern boundary of the forest are dying off. So he calls in one of his staff and sends him out on the case.

Or perhaps some of the rangers have found many dead trout in one of the streams. The supervisor will get in touch with the wildlife specialist in the regional office, who may in turn call in an aquatic biologist of the Fish and Wildlife Service to take care of the problem.

In time of war, the supervisor has extraordinary duties added to his already full peacetime list. But the man at the top can take it. The Forest Service can contribute to defensive and offensive action of the nation in many ways. With the system of lookout stations, telephone lines and radio stations at its service, it is an ideal setup for placing men in strategic positions to watch for hostile planes. Lookout stations in the West are on full-time duty in wartime.

The supervisor can put his engineering personnel and equipment to work building roads to tap new sources of valuable war minerals. He cooperates with the military authorities by contributing many of his maps, aerial photographs, relief models and other special equipment. When military officials come to consult him on the best

type of trees and vegetation for soil fixation and camouflage plantings, the man at the head of the National Forest knows the answers and gives them willingly. If in the past he has used such fire-fighting technique as that of dropping equipment and men from planes, his experience and the lessons learned can be of military value.

Such an emergency as war affects his work in other ways besides the directly military. For instance, bases may need to be planned for producing a larger volume of timber or certain special purpose woods that are in great demand because of the heavy impacts of defense on forest resources generally.

The results of research by specialists in the Forest Service provide him with the necessary facts on forest management and protection, forest influences, use of the wood products, management of livestock on ranges, and forest economics and taxation. His records of the processes used, how successful they were, and all other such items are records of importance to forest research all down the line.

The supervisor must know his job from start to finish. But personality traits are also very important. With all the technical workers, clerks, forester assistants and rangers under him, he must be able to deal with men tactfully, wisely and patiently.

He must have good health and stamina, for he has to spend a good deal of time traveling over his district in

order to see that his plans are being carried out to satisfaction. Businessman and administrator though he is, he is still a man of the forest and the outdoors.

When he closes his office door behind him, or the door of his cabin in some scenic spot in the National Forest, he has the satisfaction of knowing that he has done a good day's work and done it well. He knows the pride of the forester in every division of the Service.

Although he is the man at the top, that does not mean he has no further personal goal to work toward. He may be promoted to the position of Regional Forester or even Chief Forester. In that event he will have topped his own rôle as the top man. Even at that height, he is never so high that he can't see the long file of forest guards, conservationists, logging engineers, and brawny rangers climbing up the great ladder of the United States Forest Service in the same way that he did.

You can't stop the boys in green!

CHAPTER XII

SCIENTISTS IN SHIRTSLEEVES

"ALL right. Here goes!"

A gasoline-soaked torch is tossed against the side of a house. Instantly, flames leap high with a furious roar.

It isn't arson. Instead, it is an everyday occurrence in the life of one of conservation's scientists in shirtsleeves. Whereas the ordinary spectator would be amazed at what happens to the flaming house, the scientist nods approvingly with a calm smile.

The house that flared up in flames isn't actually burning at all. The flames are dying down as though someone were pouring water on them. Only it isn't water that makes the flames retreat in this case. It's one of the fireproofing compounds that the research worker and his colleagues have worked out. The house looks charred where the flames have swept, but that's merely a surface blemish. Underneath, the wood is as sound as ever, thanks to a certain chemical formula.

This is a different front from that of the red fire lines of the forest where the men in green fight back at the ravaging flames, but it is an equally thrilling and vital

one. It is a front that holds a challenge for the future and steadily increasing employment possibilities.

It is not enough to conserve timber as it grows. There is another important step—more and better *uses* for timber. One of the outstanding examples of systematic and successful research is the Forest Products Laboratory, a world famous institution which has been termed the "house of wood magic." This modernistic structure which stands impressively on a site of ten acres in the city of Madison, Wisconsin, is the master laboratory after which all others engaged in forest products research are patterned. Government agencies, universities and private concerns alike, follow the methods of the Forest Products Laboratory.

If you could step inside and take a look for yourself, you would see men in overalls tending model sawmills, white-coated scientists with test tubes and microscopes, men at woodworking machines, men in shirtsleeves busy with complicated devices that look like contraptions from Mars. And there are men and women at files, desks and typewriters in the many offices. These and all the others are the personnel of the FPL, the very nerve center of one of the most important conservation tasks in the world.

In order to understand why the work of the FPL is so important and how it operates, you should know certain fundamentals about timber and lumber. The main fact to be realized is that only about a third of the wood in a

mature forest ever gets to be lumber. The rest is largely waste—or used to be waste before painstaking chemists and laboratory technicians pointed the way to making more use of the materials left from sawmill and logging operations. "Waste" products are such things as sawdust, slabs and edgings from the saw; loss in the seasoning of boards; bark, stumps and brush; and trees which are considered too defective or stunted to cut.

Forest fires aren't the only great wasters of wood. Not so long ago, much valuable wood went up in smoke from the burners in mills. Part of the equipment of a sawmill was a tall, round tower called a refuse burner. Workers built a fire at the base of this and there burned all the odds and ends for which the owners could find no use. Now that use has been found for such odds and ends, the towers belch forth less smoke or none at all.

Foresters and the lumber industry are waging war together against wood waste. What has happened to sawdust alone is an outstanding example of this. It is used for fuel to keep the mill furnaces blazing, for packing and refrigeration. The government has learned how to make a food out of it that cattle eat and grow fat on. In the FPL you may see a technician pouring sawdust into a strange-looking receptacle out of which stream smoke and light. The chances are that he is preparing sawdust for conversion into a new plastic molding powder.

Wood not used for lumber can be converted into charcoal and into wood alcohol. From twenty to twenty-five

gallons of alcohol can be made from a ton of hard, dry wood.

In times past a good deal of wood was wasted because it could not be seasoned without cracking or splitting. Experts in the FPL believed, with others, that the answer was to season the wood with chemicals. Lumber in a pile dries from the outside in. The experts wanted to change the process around so that it would season from the inside out. It took them three years to do the job, even though the method is a simple enough one—now that their painstaking efforts have discovered it. They simply soak green wood in ordinary salt solutions. The salt coats the outer surface. This makes such a difference in the development of vapor pressure between the natural water in the core of the wood and the salt-saturated surface that the moisture is drawn toward the exterior and there it evaporates until the proper degree of seasoning is reached.

If you did not know this, the work of the men in the wood-seasoning and moisture-control department would not be very clear to you. The workers there are busy bathing lumber in a vat or cutting sections from walls and weighing them.

One of the workers points to a log. "See that. It's sixteen feet long and eighteen inches in diameter. Do you know how much water there is in it? More than a hundred gallons. Our job is to get that water out."

Drying, obviously, is a major task, or rather, it used to

be. A year was the usual time that it took for a Douglas fir to dry to a moisture content of 15 per cent in the open air. Today, the same job can be done in four days by the use of hot-air kilns.

As you look at one of those kilns you will see that it resembles an old-fashioned Dutch oven in shape.

"That," a worker tells you, "is a portable dry kiln. It'll cure timber faster and better than anything yet developed. We worked for two years on that before we got it just right. Lumber has to be properly cured to be considered good lumber."

In this same department where the work of timber harvesting and conversion goes on are the model sawmills, marvels of compactness. Thinner saws have been developed so that there is less sawdust left.

"Here's a sawmill," a worker explains, "that can be taken down and set up in a few hours. That's important because it means that smaller areas of timber which once went to waste can now be efficiently cut. It's a break for the small operator—and a break for forestry."

The FPL is a scientist's dream with its splendid facilities for handling, processing, testing and investigating wood in any form, from giant logs to complete buildings. It contains, in miniature, a lumber mill, a pulp and paper mill, a turpentine plant and a plastics plant.

You have your choice of many different occupations if you become a part of the FPL personnel, depending on your training and native talents. The staff is divided

equally into two groups. One group is made up of the non-technical workers, those engaged in administrative, operating and clerical work. Laboratories of this kind are a great clearing house of information about forest products, and questions pour in by the thousands, so a large administrative staff is needed. The other group, the technical staff, is made up of various scientific specialists who are Civil Service employees, junior and senior scientists, chemists, engineers, physicists and workers in several other categories.

At one time wooden radio towers could not be much higher than a hundred feet. The spike and bolt joints were not strong enough to stand up under the terrific blastings they often got from high winds and winter storms. So the federal wood investigators started testing thousands of samples of the eight leading types of metal connectors in construction using Douglas fir and Southern pine.

Before a better way was found, the old method of building such things as towers was to use oversize timbers, which were big enough to hold as many spikes or bolts as were needed. By their studies the scientists have changed things so that towers can go much higher by the use of the proper metal connectors such as split rings, dowel and key fasteners and others. Wooden radio towers can now go up 300 feet and higher. A 180-foot arched timber bridge was built in California with split rings instead of spikes and bolts.

The men working in this field of timber mechanics and structural research might be called super-carpenters, but they have to know a good deal more than how to hammer two pieces of wood together. They have to know such things as wood's toughness, its strength in tension, bending, compression and so on. The result is that wood is being placed on a technical footing with other modern engineering materials. The FPL has made nearly a hundred thousand mechanical tests of the strength characteristics of native woods.

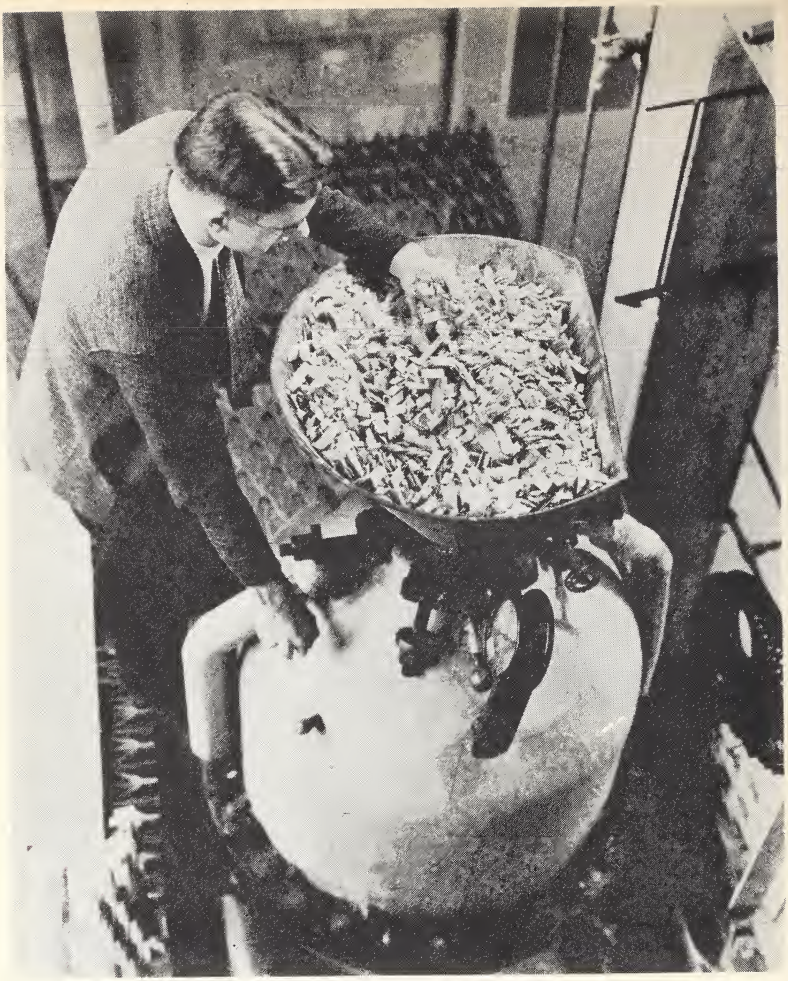
The research service building, for instance, is made of plywood panels mounted on a solid framework of glued arches which span a width of forty-six feet. The wooden arches are composed of short-length boards which have been sealed together by a water-resistant casein glue. Each arch was bent against a model curved form. Clamps were put in place until the glue set.

When the roof was completed, a tier of sandbags weighing 31,500 pounds was put on the roof along the line of one of the arches. The scientists made precise measurements of the arches' resistance to the weight—50 per cent greater than the weight of snow permitted according to building regulations—and they found that there was a deflection of only 1.04 inches at the peak of the loaded arch. The use of such arches does away with the warping that occurs in big solid timbers, and they can be made longer than any solid timber obtainable.

Plywood and plastic plywood are not the same. The



These men with a purse seine are all set for a big catch of salmon in Yes Bay, Alaska. The study of salmon is their business.



One of the outstanding examples of wood research is the Forest Products Laboratory at Madison, Wisconsin. Experiments and tests are carried on constantly to find new and better uses for wood and to get the most out of it. Wood is vital in making paper. This research worker is feeding pulp wood to a mechanical grinder which will produce pulp containing both cellulose and lignin—materials which chemists can use to create various plastic products.



The pulp is further refined in this huge beater. Refined pulp is usually added to make paper of required strength and whiteness. Whether pulp or timber, a tree is a storehouse of materials valuable in wartime and peacetime alike.



The house of wood magic where a log of spruce or maple can change into anything from women's rayon stockings to a car radiator cap. The Forest Products Laboratory at Madison, Wisconsin.

plywood in plastic plywood plays the part of the strong man, that is, it is the strength-producing binder. A method of making plastic plywood called the Vidal method works as follows: Alternate strips of plywood are placed on a mold and the layers are interspersed with sheets of phenolic resin. Then all of it is placed in a huge rubber bag and the heat is turned on. The heat, in the form of live steam, hits the bag. In a matter of minutes the plastic plywood "cooks" into the desired shape in the mold which is made either of wood or concrete.

This plastic plywood is the strongest substance, per unit of weight, that can be had. It has more fire resistance than duralumin. It is more rigid than steel. It can be molded quickly and cheaply. Planes, automobiles and homes are only a few of the possible end products from this modern wood miracle.

In fact, the whole department working with the composition of wood and with its derived products is a miracle department. From it have come some of the most amazing discoveries of our times—discoveries that have changed wood into a host of products that supply the needs of a modern industrial society in war and peace.

In this work a tree isn't just a tree. It is a storehouse of raw materials, and it's up to the research workers, the biochemists and other scientists to find new ways to use those raw materials.

Cellulose is one of these. It is probably the most important present-day product from wood, from the indus-

trial chemist's point of view. It includes the cottonlike substance of the fiber which is the basis of refined pulps and the modern family of products including rayon, lacquers, cellophane, photographic films, gunpowder, and a long list of nitrate and acetate plastics.

In order to study the fine grains of cellulose, technologists had to magnify a single fiber to a size as large as the biggest redwood tree. You can get a good idea of just what a magnifying job this was by visualizing the tree itself if it were magnified proportionately. It would be 4,000 miles high and 300 miles in diameter!

Next to cellulose, the greatest bulk constituent of wood is lignin, the material that surrounds the spider-web chains of cellulose. Lignin is a real challenge to the workers. Its chemical character and relationships are much harder to determine, and there seems to be no end to its possibilities. Already dishes, ashtrays, molded radiator caps and radio dials are the result of research with this material.

Another plastic, which resembles hard rubber, can be made from the sawdust of hardwood. It has a high density, a glossy surface, is strong and resistant to water and can be sold at the price of lumber.

The research foresters had a problem on their hands in trying to find a method for determining the twisting strength of airplane wing beams. These beams are the ones likely to break in forced or botched landings. If you had walked in on one of the scientists in the act

of performing experiments in this line you might have wondered what place blowing soap bubbles had in a research laboratory. For what they did was to cut cross-sections of the airplane wing beams to be tested. In the aluminum plates they cut holes and then blew soap bubbles through those openings, for they had discovered that the flat bubble at the end of such a pipe would give them an accurate index of the twisting strength. The volume of each bubble was determined by a micrometer screw.

Their first problem was to find a special soap which would produce a bubble that would not burst even when it was touched. That in itself meant several months of work. True to form, the research foresters found what they were looking for.

Outside of the FPL building is a long fence, which seems to be made up of square panels and at a distance looks something like a checkerboard. Walking along the fence, a notebook in hand, is one of the workers from the laboratory. He studies the square panels and then takes his notes. The fence is a test fence made out of plywood panels exposed to determine their durability.

The laboratory has built a model low-cost pre-fabricated house, using built-up plywood panels. Each panel is made by gluing plywood faces to either side of an inner structural framework. The panel is weatherproofed, insulated against sound, and electrically wired. The rigid joint formed by the glue between the plywood faces is

amazingly strong—much stronger than the formerly used nails. The floor panels of this house supported test loads of over 300 pounds per square foot over a span of 13½ feet.

One practical feature of the house is the speed with which it can be put up. Its five rooms and bath can be assembled in twenty-one hours by two carpenters with five helpers. Such a house could sell for $3,000 or less, on a mass-production basis.

In the development of timber mechanics, workers devote some of their time to improving the strength and serviceability of boxes and crates. Dummy loading materials and testing machinery which jolts packages around ruthlessly are used to duplicate the conditions they would undergo in actual transit.

In the treating of wood and its protection, the FPL uses its distinctive thoroughness. Into searing flames go pieces of wood that have been fireproofed. And, as has been described earlier, torches are thrown against houses to prove that they will not burn.

But fire is only one of the enemies of wood that the scientists in shirtsleeves have to battle. Decay is another. Of course everything is bound to decay sometime, but the process can be slowed down. Decay in wood is caused by fungi that creep into the wood cells and break them down so that all that may be left of a sturdy piece of timber is a rotten, papery mass.

Without food, moisture or air, such decay is not pos-

sible. If a piece of wood is dried thoroughly fungus can not live in it. When air is shut off by submerging the wood in water, the same thing holds true. Paint and varnish serve the purpose of protecting the wood from the entrance of decay.

The best way of all is to poison the food supply of the decay fungi. One way of doing this is to cover or impregnate the wood with creosote or some other poisonous substance. For instance, in the treating of railroad ties, the ties are seasoned carefully, then stacked in cars, and rolled into big cylinders. There live steam pours over them. The wood is softened by this steam, and a vacuum is created to suck the air and moisture out. Following that, creosote or zinc chloride is forced into the cylinder. This poisonous substance is forced into the wood cells by high pressure. An untreated tie would last only about seven years. By such a method as the one described its life is more than doubled.

Even under water, wood is not always safe. For though safe from fungi, it is not from ship worms. In the harbor of San Francisco, ship worms eat up millions of dollars' worth of wood a year. They make long tunnels in the wood of wharves, and finally the structure becomes so weakened that it breaks. The answer the research foresters give to this is the same as in the prevention of fungus decay—poisoning of the food supply.

In the department of the FPL which studies pulp wood and paper, the job is to find how to get a higher

yield from our native woods. Workers operate a peculiar-looking trough which reduces wood to pulp size by means of a mechanical clipper. Others work with a huge, tank-like chrome-nickel lined digester in conducting pulping experiments over a wide range of chemical concentrations and pressures. Or they may be busy around what looks like an odd-shaped mixing bowl which refines the pulp further by means of an electrical beater. Some will be at work at the press and drier rolls where the pulp is transformed into paper. Special attention is paid to the production of newsprint from Southern woods.

The research scientist in wood is a vital worker in national defense. Minor forest products are growing more important because of the shutting off of former sources of such supplies as rubber, cork, fats, oils and various drugs. The research foresters are working to make up the deficiencies. For instance, work is being done on the use of bark from native trees as a substitute for cork. Wood, nuts and bark—all are possible sources of many more valuable drugs, fats, and oils than generations before could ever have dreamed.

You've seen pictures of the modern soldier wearing leaves on his helmet, cannon draped with nets and tree branches, and airplanes daubed with green and gray paint. The scientists in shirtsleeves have a part in this too, for who is better qualified to know the secrets of camouflage than these men who work with vegetation

every day? They can transfer their knowledge of protective coloration in nature directly to the battlefield.

The Forest Products Laboratory conduct other experimental stations. Six of those named in the following list are maintained at universities and work in cooperation with them.

Allegheny Forest Experiment Station, Philadelphia, Pennsylvania
Appalachian Forest Experiment Station, Asheville, North Carolina
California Forest and Range Experiment Station, Berkeley, California
Central States Forest Experiment Station, Columbus, Ohio
Intermountain Forest and Range Experiment Station, Ogden, Utah
Lake States Forest Experiment Station, St. Paul, Minnesota
Northern Rocky Mountain Forest Experiment Station, Portland, Oregon
Northern Rocky Mountain Forest and Range Experiment Station, Missoula, Montana
Pacific Northwest Forest Experiment Station, Portland, Oregon
Rocky Mountain Forest Experiment Station, Fort Collins, Colorado
Southern Forest Experiment Station, New Orleans, Louisiana
Southwestern Forest and Range Experiment Station, Tucson, Arizona
Tropical Forest Experiment Station, Rio Piedras, Puerto Rico

Research in these stations is concerned with many phases of forest protection and management—studies of fire danger, timber growth and yield, livestock range management, watershed protection, and so on.

In recent years, 20 experimental forests and 4 experimental ranges have been set aside by formal proclamation, and 24 natural areas have been established for investigative purposes. Other experimental forests and natural areas are being selected.

The scientists working in these stations are speeding up nature in many ways, just as the forest ranger out in the woods is speeding up the growth of trees by helping the trees get more light and creating artificial plantations.

Out of a hundred thousand seedlings, only ten trees may result after drought, disease, storms and other enemies have taken their toll. The scientists in shirtsleeves try to make those ten trees do the work of the thousands that are lost.

CHAPTER XIII

FORESTS AND SMOKESTACKS

WHEN we leave the forest for the sawmill, we find an entirely different atmosphere. Here our ears ring with the shrill whistling sound of the bright saws. Log carriers flash back and forth on the short rails. The big, wet logs roll down the incline to the spot where swift, metal arms push them in place. Speed, noise and the strong smell of new lumber—such is the interior of a modern sawmill. Here the forests are being fed into the machines of industry.

The lumber is being made for two reasons: first, for a profit to the owner of the mill; second, for the use of the consumer. Where does the forester fit in? The forester comes before either of the other two, for it is with him that the forest has its beginning and its preservation. Neither the mills nor the public could receive the benefits they do without the woods themselves to turn to. Private companies are waking up to the fact that in order to keep their busy saws and carriers going they will have to start imitating the forestry methods used in our National Forests and hire trained foresters

to show them how. It's important to the public, too, that this should be done, for four-fifths of our forests are nationally or state owned. If timber is exploited for the sake of profit alone, the public itself is going to suffer.

It hardly seems possible, but private capital still often raises the question, "Will forestry pay?" The answer the forester gives is that it is the only thing that will pay. The success already evident in the National Forests proves it. Here and there some industrial reforestation is going on. A number of lumber companies on the West Coast in the redwood country have established nurseries and are planting young redwoods. In forty years those young redwoods will be ready for cutting and their rapid growth should mean good profits to the far-seeing industrialist. Another large lumber company in the South is planting thousands of pines each year. By the time the company has cut down all its present mature timber, the young trees will be ready for harvest. In the Northeast there are many privately owned plantations which are proving that forestry does pay—to the owner and to the community as a whole. Scientific forestry principles are being practiced on these tracts of private timber—seed trees are left standing, fires are prevented and controlled, and all other means of keeping healthy, growing trees are used.

Practically no private forestry has been used in the higher mountainous regions, however, for growth there

is too slow and the timber regions are too far away from the milling centers.

These examples of forestry are all too few. For all the preservation of timber on these scattered tracts, millions of acres are still being destroyed by ruthless logging practices that have no thought of the future. One of two things will happen. Either the private forest owners will be compelled to seek the help of forestry because of their own purse considerations, or the government will legislate compulsory regulations.

We may have to imitate the European method. Material that takes a short time to grow—ties, mine props, small-sized lumber, poles, posts—is raised on private forests. The big trees that may take nearly a century to mature are grown largely by the government. This is the logical answer, some foresters believe, because a private timber owner must bear the burden of interest and taxation while the government is free of those.

Some private owners make provisions for timber insurance by enforcing fire protection to the uncut timber, while leaving the logged areas to take care of themselves. This is not forestry in the true sense, for it does not concern itself with the future crop but only with that which remains to be cut.

Credit must go to private enterprise, however, for its work in research. Much has been done in the way of discovering new uses for wood, wood that at one time

might have been cast off as so much waste. Manufacturing methods have also been constantly improved.

Often mining companies own lands that are covered with trees. Many of them in the Southern mountains, especially coal-mining companies, own land which they want to hold for mineral development as well as for the production of wood and timber for use in the mines. A number of these companies are interested in treating timbers with chemical preservatives and others have taken up the problem of conservative management of the forest lands they own.

Another class of private owners consists of those who have acquired forest property for recreational purposes such as hunting and fishing. Some of these owners are using basic forestry principles in the management of their game, and are employing foresters to take care of their property. Relatively few large tracts of land in private estates, however, are managed at present with a trained forester in charge. More often the work is done by a resident caretaker or woods foreman.

There are now a number of private firms and individuals who act as consulting foresters. Such work is the natural goal of many of the more mature and experienced men who have got a firm footing in the profession. Younger men are sometimes employed in this work as assistants and members of field parties.

More and more private firms, however, are discovering that a little investigation can solve a lot of troubles.

The following example of what a federal forester's trained approach did to help a certain lumber company is symbolic of what forestry can do for the industry of lumbering as a whole.

The company was worried about its expenditures. It wanted to know how it could get the most out of its timber with the least cost. A federal forester made an investigation into the cost of cutting and manufacturing lumber from trees of various sizes. As a result of his report, the company discovered that by leaving trees below a certain size they could save money. Every log that they cut and manufactured below this size meant a financial loss. By adopting the forester's suggestions, the company saved about two hundred thousand dollars a year—not only a great saving of money but a saving of trees. Forestry and private enterprise can work hand in hand to the mutual benefit of the country and the individual businessman.

There are two broad lines of private forestry work in which you may find a place if you have the proper experience and training. The first one deals mainly with harvesting and the woods themselves. The other is concerned chiefly with the manufacture, remanufacture, conditioning, sale and use of the products.

Owners of large and medium-sized timberland tracts need at least one, more likely several, foresters trained for mapping, cruising, estimating, making growth studies, fire control, and all the other activities that timber man-

agement requires. This type of training can be obtained in accredited colleges, as it is a type of work similar to that of the regular forest ranger.

The logging work of these large companies, as well as the manufacture and selling end, offers another place where foresters can do much.

Smaller owners need the service of permanent foresters or a part-time consulting forester, depending on the size and condition of the forest and how it is to be handled. Here is an open field and a large one. As a consulting forester, it would be your business to convert trees into money at a profit to the owner, and at the same time leave the woods in good growing condition. You should know how to conduct logging operations, what the markets are, the quality and the worth of the products, the costs of transportation and manufacturing. And you should know the strong and weak points in contracts, what a day's work in all departments involves, and what the financial aspects are on the whole. In other words, you are a valuable combination of logger, sawmill operator, and businessman, the kind of man a lumber company will pay high rates for.

In the field of utilization you will need special training. You may find full-time or only part-time work in this field, depending on the size of the company employing you.

Wood-manufacturing plants need men who know machinery and wood and how to handle them. Your job

in such a factory is to buy raw materials and to condition, fabricate, assemble, finish and merchandise them. Here there are many challenges and problems, as well as many opportunities. There are thousands of these wood-fabricating plants, most of which can use one or more men trained in a forestry school.

The sphere of wood treating and conditioning is more limited. It does not require any great degree of specialized training. You may find it an adequate stepping stone to other fields.

The ownership of a lumbering business may seem like a far cry from that of practicing forestry. But some of the most successful forestry school graduates are those who are in business for themselves. In considering such a step, it is obvious that you would need not only capital and credit but a good many years of experience.

Another type of worker that industrial forestry can use is the salesman, either for wholesale or retail selling. Actually, you would serve as a sales engineer and the contact man between tree and consumer. Selling wood is a specialized job, just as is treating or conditioning wood.

These are not the conventional conceptions of the profession of forestry, it is true, but they are approaches which may have to be considered in the future and provided for more and more.

All this does not exclude the regular type of field work done by men in the Forest Service. Some companies

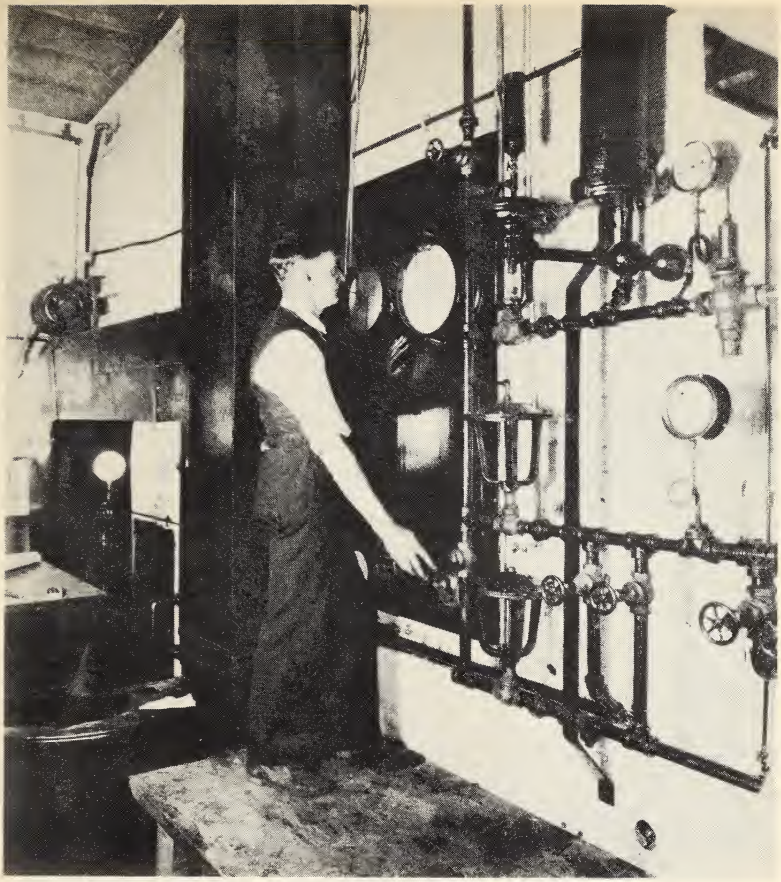
own or control anywhere from 50,000 to 500,000 acres of timberland or more, and they have to see to it that the forests are protected and otherwise cared for in much the same manner as are the National Forests. This offers a chance to be a private forest ranger doing work much like that of the men in the Forest Service.

Lumber companies are not the only ones who are finding out that they must find a place for foresters in their personnel. Water companies have started using forestry on the side, planting trees at the headwaters of their stream sources. Forest trees about reservoirs and streams help to preserve the clearness of the water and prevent silt from clogging the reservoirs after heavy rainfall. Coal companies and railroads, too, are finding it profitable to raise their own timber products.

The picture would not be complete without mentioning briefly the field of the paper industry, for next to lumber, paper is the most important forest product. Paper pulp companies are hiring foresters to help them grow more wood near their mills to save the increasing costs of transportation.

There are only a few species of trees that can be used for making paper, although scientists are developing new processes all the time. An enormous volume of wood is used in the production of paper. The supply will equal the demand only if the same forestry practices are used by private owners that are used in the National Forests.

The forest ranger is ready to help. His tradition of



You have to be clear-headed to keep track of all these dials and gauges if you want to be on the operating end of the Forest Products Laboratory experimental dry kiln. A kiln is a huge oven which dries and cures the timber in much faster time than would be possible with simple outdoor seasoning.



This friendly ranger is typical of all the men in green. The ranger never becomes so absorbed in the exciting details of his work with the forest that he forgets the people who depend on them for their recreation and livelihood. Whether it's issuing a campfire permit or helping tourists plan their trips through the forest, the ranger does it in such a way that he makes others want to help out in the great cause of preserving America's timber.

defending and using the trees for the good of all must become the tradition of the private forest owner too.

Will it pay? It is the only thing that will pay in the long run. For every cord of lumber gleaming in the stacks of the lumber yard, there must be the same amount of timber growing to take its place.

CHAPTER XIV

HERE'S YOUR DIPLOMA

"SO YOU'RE going to Europe to learn how to be a forester!"

Such a remark today would be ridiculous. But not so many years ago it would have been merely an accurate statement of fact. For when Gifford Pinchot, our first national forestry chief, wanted to attend a forestry school he had to cross the Atlantic to do it. The picture is different now. By 1941 there were already twenty-seven accredited forestry schools in the United States, with the prospect of more and more in the future. In the spring of that same year, a thousand young foresters were graduated from American universities.

In Pinchot's time there was no such thing as a *job* in conservation, to say nothing of educational centers. The real inauguration of professional courses began in 1898 at Cornell University. At Yale they were started a little later, and in 1903 at the University of Maine, Harvard, Iowa State College, Michigan State College, and Pennsylvania State Forest School. Minnesota and Nebraska Universities soon followed suit.

The importance of proper training now and in the future should not be overlooked. As the number of foresters steadily increases you will find the competition more keen and the need of a thorough education much more necessary. After all, forestry is a profession, and if you enjoy the thought of the adventure and varied scope that it offers you, you will feel that going through college is a part of the necessary training to accomplish it.

Four years of college work are usually required. With that you can find your place in the line of men working for the United States Forest Service. A course of five or six years—one or two of which are spent in post-graduate work—is better yet. If you plan to look for employment in the lumber business or other forest-using industries you will find your forestry training as valuable for success as it is to the men who plan to specialize in strictly scientific and technical work.

Aside from the courses given by the colleges which offer complete training in forestry, many other places of education include parts of such training in their curricula, the instruction being given on a non-professional basis as supplementary training in other degree courses.

You can obtain first-hand experience in forest or conservation work in the summer which will help you stay in college and also give you a background of practical value. The seasonal work of a forest laborer or forest guard is one door open to you. Or you can get experience in summer school or field work during summer vacation

periods either in a federal or state forest, a conservation organization or in the employ of a lumber company. Men who plan to specialize in lumbering find that work in logging camps and mills is valuable for learning the practical details of the business.

In preparation for a forestry career, Arthur D. Read, Master of Forestry, recommends the following subjects in high school and junior college: botany, geology, English, mathematics, zoology, general biology, chemistry, and public speaking.

In the higher colleges elementary forestry courses will include:

Dendrology, the natural history of trees
Plant physiology, the organs and growing habits of all plants
Plant pathology, the diseases of plants and their treatment
Wood anatomy, the interior wood structure of trees and their identification
Entomology, the life and habits of insects
Soils, their structure, composition, differences and their effects on plants
Surveying, for the laying out of forest bounds and roads, and the making of maps
Drafting, the drawing of plans and especially of maps, to show forest features

You will engage in intensive technical courses, especially as a graduate student, in the following:

Silviculture, the care and raising of trees
Forest management, with all its problems of administration, use, protection, and sale

Mensuration, or computing of quantities of standing timber or felled logs
Forest protection
Forest products
Forest economics
Lumbering
Logging
Milling
Forest law

You may specialize in logging engineering, range management of forests for their pasture and timber values, game or wildlife management, and even in city forestry.

The general cultural subjects are grouped into the first two years of college; the general forestry courses into the junior and senior years; and the advanced technical courses into the Master of Forestry year. You may go further, doing research work in part, in a few schools, for the degree of Doctor of Science in Forestry. Many schools have experimental forests of their own for the use of their students, these forests almost always being at some distance from the campus.

The cost of a college education in forestry is on a par, generally, with the cost of any other professional education. A minimum of $700 a year is usually estimated, with an increase of $200 or more a year when advanced work necessitates more field trips to forests.

When your schooling is finished, you will probably begin, if in state or federal service, through Civil Service

appointment, as an assistant forest ranger or junior forester. In the announcement of a Civil Service examination for the position of junior forester, the qualifications will usually be similar to those paraphrased in the following:

"An applicant for the position of a Junior Forester should have had 20 semester hours in range management, pasture management, or plant ecology, or any combination of these subjects, or in one or more of these subjects combined with a course in forestry, botany, agronomy, or animal husbandry.

"He must not be over thirty-five. He must be in sound physical health. For positions where arduous duty in the field is required, any serious physical defect will disqualify for appointment. A rigid physical examination will be made by a Federal medical officer before appointment."

A good forester is well developed mentally, physically and morally. Initiative and imagination help him toward success in his chosen field. Both forest and factory demand more and more highly intelligent specialists who can do difficult things wisely and well.

The kind of outdoor physical work you will be engaged in is conducive to increased development of health and strength. There is every opportunity for you to grow mentally as well, for you will be constantly learning more about trees and their problems and about the people with whom you must deal.

There is no government school of forestry. Advertise-

ments of correspondence schools which claim to prepare you for ranger work and practically guarantee government employment upon the completion of their courses are in no way authorized by, or connected with, the Forest Service. Many of the statements in these advertisements are misleading or actually false. They frequently convey the impression that if you become a forest ranger you will have largely a play-time job.

No institution is authorized to guarantee such employment after its course is completed. All permanent positions are under Civil Service, and attaining a passing mark often depends largely upon experience, which no school can give by correspondence. The knowledge which you must have to answer the practical questions comes mostly from actual experience in the woods and on the range. In the colleges and universities which give forestry courses at the institutions themselves, the instruction is given by men who are properly qualified by experience in forest work, and at some institutions with practical demonstration in the woods.

Technical men already in the Service who wish to advance to positions of administrative responsibility generally acquire experience enabling them to qualify for employment as assistant district ranger. A year or more of successful work as an assistant district ranger ordinarily precedes the advancement of a technically trained man to a position as ranger assistant to the supervisor, or to work as a specialist.

If you have the education, the physical fitness, and the true desire to work in the dynamic field of American forestry, you can go far in this career. If it is the job for you, good luck, Ranger!



A fisherman's land of dreams. Only by the constant work of rangers, managers and scientists in the Forest Service and the Fish and Wildlife Service could such a dream come true.



NATIONAL FORESTS OF THE UNITED STATES



The ranger in the National Parks is a host to countless pleasure seekers. Without wishing the skier in the picture any bad luck, the chances are a hundred to one that a ranger would be his rescuer if he should get lost in the mountains or have an injury. This scene is in the Olympic National Forest, Washington.



Part of the Forest Service's job is to put its park visitors on the right track. Under the supervision of its Operation and Information Department, signs are posted; and foresters are always on the job at the ranger stations.





Whether the ranger is invited to join in the singing with this group of campers in the Sawtooth National Forest, Idaho, he is the man who helps make such a scene possible. In return, he expects the campers to keep a watchful eye on that fire.



This forest ranger is working in cooperation with the Michigan Conservation Department in taking a census of the number of trout caught in order to determine the productivity of trout streams. The forester is interested not so much in the fish story the angler is telling as he is in the number of trout in his basket.



Those wooded mountainsides in the background could look a lot different if the rangers weren't around to keep the timber free from fire. As it is, these canoeists on Redfish Lake in the Idaho Sawtooth National Forest have a perfect setting of timber and crystal-clear water for their outing.

APPENDIX

SCHOOLS WITH COURSES LEADING TO A DEGREE IN FORESTRY

This list has been compiled by the United States Forest Service to aid in answering inquiries regarding schools providing instruction in forestry. While every effort has been made to avoid errors, the Forest Service does not vouch for the completeness of the list, its accuracy, or the relative merits of the courses offered. Before a final selection is made by the prospective student, he should obtain more detailed information direct from the schools.

Schools which are indicated by an asterisk are rated as accredited forestry schools by the Council of the Society of American Foresters, an organization whose senior membership is composed of professional foresters. Information as to the method used by the Society in rating the schools may be obtained by writing the Secretary, Society of American Foresters, Mills Building, Washington, D. C., or from the pamphlet "Accredited Higher Institutions—1938" issued by the Office of Education, Department of Interior. This pamphlet may be obtained from the Superintendent of Documents, Washington, D. C. Its price is 20 cents.

* * * * *

* *California, University of, Department of Forestry, Berkeley, Calif.*

Both undergraduate and graduate training. The undergraduate course, leading to the degree of Bachelor of Science (in Forestry), requires a minimum of four years. The student is strongly urged to broaden his training by a fifth year if possible. The undergraduate course prepares men for the practice of forestry or range management (grazing). It also serves as the foundation for graduate training. Graduate instruction is strongly emphasized. Graduate training is available in plant physiology, soil science, ecology, silviculture, mensuration, management, forest economics, forest influences, wood technology, range management, forest entomology, and plant pathology. The degree of Master of Sci-

ence (in Forestry) and the degree of Doctor of Philosophy are granted to students of forestry.

* *Colorado State College, Division of Forestry, Fort Collins, Colorado.*

A four-year course leading to the degree of Bachelor of Science in Forestry. Starting with the junior year students may continue in general forestry or secure fundamental training in recreation management, game management, or range management. Range management is a separate curriculum and those interested should consult "Schools with Courses in Range Management" published by the U. S. Forest Service. A forestry camp of 10 weeks is held following the sophomore year. Camp enrollment is limited, and applications must be in by May 1st. In addition to college lands, the Roosevelt National Forest makes available a going demonstration of forest management. Proximity of the Rocky Mountain National Park provides exceptionally favorable opportunities for instruction in recreation management.

Connecticut State College, Storrs, Connecticut.

Four-year course leading to degree of Bachelor of Science in Agriculture with a major in forestry. The first two years of undergraduate work are general foundation subjects. The last two years are elective under adviser system, the objective being a good foundation in non-agricultural land management. Foundation courses are available in forestry, game and fish management and in soil erosion. The college woodlands and water are adjacent to the campus and serve as field laboratories.

* *Duke University, School of Forestry, Durham, North Carolina.*

Two years of college work in forestry and one summer term of twelve weeks are required of candidates for the degree of Master of Forestry. Men entering from other forestry schools with degrees in forestry are required to be in residence at least one full school year before receiving the M. F. degree. They may specialize in one or more branches of forestry, namely, forest soils, silvics, silviculture, wood anatomy and properties, forest mensuration, forest pathology, forest entomology, forest management, forest utilization, forest economics, or forest-tree physiology. Graduates of universities, colleges, or schools of high standing may become candidates for the professional degree provided they have fulfilled the necessary entrance requirements. The School maintains a demonstration and research forest of 5,000 acres adjacent to the campus. Special facilities are available in the laboratories, library, and School

forest for research and advanced study for the degrees of Master of Arts and Doctor of Philosophy. A limited number of scholarships and fellowships are available for students of high standing who have demonstrated an aptitude for professional or scientific work in forestry. A pre-forestry curriculum is offered to undergraduate students in Duke University.

Florida, University of, School of Forestry, College of Agriculture, Gainesville, Florida.

Four-year course leading at present to the degree of Bachelor of Science in Forestry and the Semi-Professional or Ranger Course leading to the Certificate of Award for two years' work. These courses include eight weeks at summer camp and field work on the four National Forests of the State and upon the State Forests and State Parks. Emphasis is placed upon the management of slash pine in the South.

* *Georgia, University of, School of Forestry, Athens, Georgia.*

A four-year course leading to the degree of Bachelor of Science in Forestry. Special emphasis is placed on southern forestry and naval stores. An opportunity for field work in the Piedmont Section is offered on the School forests adjoining the campus. A ten weeks' summer camp following the sophomore year is held in North Georgia on a 5,800 acre forest owned by the School. In the senior year the spring term is spent on a 40,000 acre forest located in the southern part of the State and leased from the State Division of Forestry, where special attention is given to work in management and naval stores. The school is housed in a new Forestry Building which contains—in addition to the usual classrooms and laboratories—a special forest library, research laboratories, and special utilization laboratories for work in the lumbering and naval stores industry. Graduate courses leading to the degree of Master of Science in Forestry are open to qualified students.

* *Harvard University, Harvard Forest, Petersham, Massachusetts.*

Graduate specialization and research leading to the degree of M. F., M. A., and Ph. D. In connection with the management of the Harvard Forest and as part of its work as a forest experiment station, opportunity is offered for advanced study ordinarily in the form of investigation in silviculture, forest tree physiology and genetics, experimental silvics, forest soils, forest management, economics, utilization, and wildlife management. All technical work in forestry is conducted from the Har-

vard Forest as headquarters; instruction in associated biological subjects, such as forest pathology and forest entomology, and in forest economics is given in Cambridge. For students in forest economics a program may be arranged for joint instruction by the Department of Economics of the University and the Harvard Forest. Also open to students at the Harvard Forest is a seminar in agricultural, forestry, and land-use policy conducted under the Graduate School of Public Administration. General instruction in the history, culture, protection, use, and economic importance of local forests will occupy the first two months. Thereafter the student will undertake specialized study in silviculture, tree physiology and genetics, forest soil science or such other forestry subjects as may be arranged for in collaboration with other members of the Department. Scholarship aid for properly qualified and deserving students is available.

* *Idaho, University of, School of Forestry, Moscow, Idaho.*

Four-year undergraduate course leading to degree of Bachelor of Science in Forestry. Three distinct curricula are available—forest production, wood utilization technology, and range management. These curricula are all fundamental for the encompassed field selected. Graduate work in the selected field is necessary for specialization. Wood utilization technology curriculum offers a foundation training in forestry, wood chemistry, and wood technology. Special emphasis is given to the utilization of wood wastes in all graduate and research work. A five-year curriculum that offers a wide range of electives is recommended as a desirable choice. A fifth year, leading to the degree of Master of Science in Forestry, is possible in all curricula. Following the sophomore year, a ten weeks' summer camp is required of all students. Library, laboratory, nursery, experimental forest, private, state, and national forest areas are readily available for extensive field work.

Idaho, University of, Southern Branch, Forestry Department, Pocatello, Idaho.

First two years' instruction for forestry courses. When students have completed the two years' instruction, they receive full credit in the University of Idaho or at neighboring schools of forestry where they may continue work to obtain a Bachelor of Science degree.

* *Iowa State College of Agriculture and Mechanic Arts, Department of Forestry, Ames, Iowa.*

Four-year professional course in general forestry leading to the degree of Bachelor of Science in Forestry. Also five-year courses in forestry and wildlife management, forestry and range management, forest utilization, and forestry and general conservation. An eight weeks' summer camp under faculty supervision is required between the freshman and sophomore years, and in addition a minimum of three months of practical experience in some phase of forestry must be gained before graduation. Qualified forestry graduates may also enroll in the Graduate School for work toward the degree of Master of Science. A regional nursery of the Soil Conservation Service and an eighty acre State nursery are available for school study at the college. Also a 3,000 acre school forest is available for student field activities.

* *Louisiana State University, Department of Forestry, University, La.*

Four-year course leading to the degree of Bachelor of Science in Forestry. For this year, we are offering a general forestry course with limited specialization. Two separate curricula are offered—one in forest land management, in which elective courses may be taken to provide a limited degree of specialization in silviculture, forest management, or game management. This specialization is limited, however, as the course is set up without many electives. The second curriculum is in forest utilization, and is designed to prepare men more definitely for private industry, or for any private forestry work, be it forestry practice, or the utilization of the products of the forest. One summer term of six weeks is required in camp on the school forest at Bogalusa, Louisiana. The department provides its own transportation, and most of the laboratory work listed during the regular school year is taken in the field by traveling to nearby forest areas where actual practice in field work is obtained. In addition to these trips, the Senior class spends the last six weeks of the senior year in the field. Graduate work is offered in silviculture, forest management, and utilization.

* *Maine, University of, Department of Forestry, Orono, Maine.*

Four-year course leading to the degree of Bachelor of Science in Forestry. Graduate work leading to the degree of Master of Science in Forestry. Special attention is given to forest management and forest engineering, applicable to the Northeastern United States. Summer

course of six weeks required between sophomore and junior years. Senior camp of nine weeks required on State-owned land on 17,000 acre forest. A four-year course in pulp and paper is also given in the chemical engineering department.

Massachusetts State College, Department of Forestry, Amherst, Mass.

A four-year course leading to the degree of Bachelor of Science. Emphasis throughout is placed on the sciences basic to forestry and on supporting cultural courses. The courses in forestry are designed to be broadly explanatory of the objectives and methods of forestry and do not purport to provide complete technical coverage of the field. Together the work in the basic sciences and forestry are intended to provide a strong foundation for professional work in forestry to be taken at one of the graduate schools. This pre-professional approach to training in forestry has been successfully followed for the past ten years.

* *Michigan State College, Department of Forestry, East Lansing, Michigan.*

A four-year course leading to the degree of Bachelor of Science in Forestry, with graduate courses leading to the degree of Master of Science. A summer camp of ten weeks between the sophomore and junior years is required of all students and is held at the Dunbar Forest Experiment Station near Sault Ste. Marie, Michigan. At the beginning of the junior year each student must elect to do his major work in one of the five following options: Forest Management for Wildlife Production, Forest Management for Wood Production, Forest Management for Soil Conservation, Recreational and Municipal Forestry, and Forest Utilization and Merchandising. In all of these majors the men receive the broad, general training of foresters with emphasis, however, in their major field. Thus, in major five, Utilization and Merchandising, the emphasis is on forest products, technology and economics.

* *Michigan, University of, School of Forestry and Conservation, Ann Arbor, Michigan.*

A four-year course leading to the degree of Bachelor of Science in Forestry, and a five-year course leading to the degree of Master of Forestry. The five-year course is strongly recommended for those who desire a thorough training, and particularly for those who wish to specialize or to go into any form of research work. Two distinct curricula are offered—one in Forest Production and one in Wood Technology. The

Forest Production curriculum is in turn divided into "General," "Industrial," and "Wildlife" programs of study. Ample opportunity is also afforded for work leading to the doctorate in forest management, silviculture, forest and wood utilization, forest economics, forest pathology, forest entomology, forest zoology, and wildlife management. Attendance at a ten-weeks' summer session in camp in the Upper Peninsula is required for those in the Forest Production curriculum and fits in best during the summer following the sophomore year. This should be borne in mind by candidates for entrance from junior colleges or other collegiate institutions. Combined curricula in effect with the College of Literature, Science, and the Arts, the College of Engineering, and the School of Business Administration enable superior students to obtain both an A. B., B. S. E., or M. B. A. degree and a degree in forestry in less time than would otherwise be possible. The library, laboratories, and experimental areas maintained by the school are ample for the needs of the student and for research activities.

* *Minnesota, University of, College of Agriculture, Division of Forestry, University Farm, St. Paul, Minnesota.*

Five-year course leading to the professional degree of Master of Forestry and offering three lines of specialization: Technical forestry, range management, and game management. The Bachelor of Science degree is granted on completing the first four years of these five-year curricula, but this degree is not a professional forestry degree. Four-year nonprofessional curricula in commercial lumbering and wood technology are also available. Students enrolled in any of the professional curricula spend the fourth quarter of the freshman year in the field at the Lake Itasca Forest Biology Station and the third quarter of the senior year at the Cloquet Forest Experiment Station. Graduate courses leading to the degrees of Master of Science and Doctor of Philosophy are open to properly qualified students, to whom the research facilities at the Itasca and Cloquet Stations are available.

* *Montana, University of, Forest School, Missoula, Montana.*

Four- and five-year courses allowing specialization in the general fields of forestry or range management during the junior and senior years, leading to the degree of Bachelor of Science in Forestry. The courses prepare men for technical positions in public and private forestry and in the general fields of forest utilization. A one- or two-year post-graduate course leading to the degree of Master of Science in Forestry is open

to those possessing undergraduate degrees in forestry, forest engineering, or range management from an accredited college or university. Facilities are afforded in laboratories and in the school forests for research and investigative work in silviculture, forest ecology, wood technology, forest management, nursery management, and range management. Registration is rigidly limited. Prospective students should submit transcripts of their previous high school or college records for evaluation and approval.

Nevada, University of, College of Agriculture, Reno, Nevada.

Four-year course leading to the degree of Bachelor of Science, in Agriculture. This course gives training in botany, animal husbandry, surveying, and a general course in forestry. A Master's degree is given upon the completion of a year's graduate work with thesis in any one of the above special fields. In addition to the general course in agriculture, a new course has been inaugurated in forestry and range management leading to the Bachelor of Science degree. This course is especially provided to prepare young men for work in forestry and range management.

New Hampshire, University of, Durham, New Hampshire.

Four-year course leading to the degree of Bachelor of Science. Special emphasis is laid upon local conditions with the idea of training men for work in New England.

** New York State College of Forestry at Syracuse University, Syracuse, New York.*

A four-year course leading to the degree of B. S., and graduate work leading to advanced degrees. The undergraduate work covers five separate curricula, including adequate training in basic sciences: (1) General Forestry, with optional courses in Forest Botany, Forest Entomology or Forest Zoology; (2) Landscape and Recreational Management as applied to extensive areas; (3) Wood Technology; (4) Conversion and Distribution of forest products; (5) Pulp and Paper Manufacture. Opportunity is offered for graduate work in the various branches leading to the advanced degrees of M. F., M. S. and Ph. D. The College has charge of 22,000 acres of forest properties for laboratory use, demonstration and research. Field instruction includes trips to organized forest and wood-using industries in the east and south. Attendance at summer camp is required, following the sophomore year, except in the case of students in Pulp and Paper Manufacture, who are

required to secure practical experience in a paper mill, in lieu of summer camp.

* *North Carolina State College of Agriculture and Engineering, Division of Forestry, State College Station, Raleigh, North Carolina.*

A four-year course leading to the degree of Bachelor of Science in Forestry and an additional year leading to the degree of Master of Science in Forestry. The field work is conducted on the forests owned by the forest school. The greater part of the work is done during the summer camps. There is a summer camp period for the sophomore class for ten weeks following the third quarter. The school has title to 87,000 acres of land in three different forest units representing the Coastal Plain type and the Piedmont Section. In addition to this, there are smaller tracts like the Poole virgin woods and the Prison Farm tract. The school nursery produces about a half million trees per year and an arboretum is being developed. The senior class takes a trip of more than five thousand miles covering the forest conditions and industries through the Southern States from Florida to Arkansas and the Tennessee Valley.

* *Oregon State College, School of Forestry, Corvallis, Oregon.*

Four-year course leading to the degree of Bachelor of Science in Forestry, in Logging Engineering, and in Wood Products. Opportunity is given undergraduates to specialize in recreation and in grazing. A five-year program leading to a Master of Forestry degree is provided for those students who desire to be broadly trained for the management of wild lands. The degree of Master of Science is conferred upon the satisfactory completion of an advanced program for students desiring to enter research work. At least six months of approved field work is required as a prerequisite to graduation. Ample facilities for field work are provided. A forest nursery producing 1,000,000 trees annually is near the school. A school forest of 5,000 acres, located within twenty minutes of the campus, provides space for work in mensuration, surveying, and forest engineering. Large logging operations and sawmills are located within an hour's ride of the college.

* *The Pennsylvania State College, Department of Forestry (The Pennsylvania State Forest School) State College, Pennsylvania.*

Four-year under-graduate course in forestry, leading to the degree of Bachelor of Science (in Forestry). Graduate courses in silviculture,

forest pathology, forest soils available to selected graduate assistants. Also graduate work in wildlife research available to selected assistants through the Pennsylvania Cooperative Wildlife Research Unit (U. S. Biological Survey, Pennsylvania State Game Commission, The Pennsylvania State College cooperating). The freshman year is held at Mont Alto, Pennsylvania, where students supplement their regular academic classroom work by observation of and participation in state forest administration and practice. This is made possible by the location of the Mont Alto State Forest and the State Forest Nursery in the immediate vicinity. A camp of eight weeks is required at the end of the sophomore year. This camp is located on the Allegheny National Forest in northwestern Pennsylvania, in direct contact with Forest Service officers and procedures. A school forest of 4,500 acres for instruction and research within one-half hour of State College and College woodlands of 700 acres are directly under department management. Junior students may elect one of the following options: Lumber industry, wood utilization, forest pathology, forest entomology, forest soils, game management, range management, forest economics, forest research and forest recreation.

A two-year vocational course is offered which is designed especially for older students with experience who cannot meet college entrance requirements. It is open to students at least nineteen years of age who have completed satisfactorily not less than two years of high school or its equivalent in experience, and who possess maturity of mind sufficient to pursue the courses offered.

Purdue University, School of Agriculture, Department of Forestry, Lafayette, Indiana.

Four-year course leading to the degree of Bachelor of Science in Forestry. Students are given an opportunity to specialize in forest pathology, forest entomology, or general forestry. Numerous trips are made to local wood-using industries. Special opportunities for foresters interested in erosion problems. Location of the Indiana Agricultural Experiment Station at Purdue University makes for opportunities in forest research. Field work includes eight weeks in summer camp at the Clark County State Forest of nearly 6,000 acres, and is also pursued through the year on various Indiana woodlands and utilization projects. Special courses in wildlife management.

* *Utah State Agricultural College, School of Forestry, Logan, Utah.*

Four-year courses are offered in forestry, range management, soil conservation, and wildlife management upon completion of which the degree of Bachelor of Science is granted. A fifth year of training leading to the degree of Master of Science is offered in range management and wildlife management. A limited number of assistantships are available to graduate students in these two fields. Courses are designed to give an accurate picture of land use problems in the intermountain region with special attention being given to the administration and technical problems of timber, recreation, range forage, soil and game management. Federal and State agencies with active projects in or near Logan which afford unlimited opportunity for field experience are the Forest Service and experiment stations, Grazing Service, Bureau of Animal Industry, Soil Conservation Service, State Fish and Game Department, Fish and Wildlife Service, and Wildlife Experiment Station. Further field experience is obtained in a required ten-week forestry summer camp carrying regular college credit, and in organized field trips through Utah and adjacent states.

Washington, State College of, Department of Forestry and Range Management, Pullman, Washington.

The work in forestry proper, covering the essentials of a general course in forest production, is condensed into a three-year course. All the work offered is of full college grade, however, and may be applied as credit toward the Bachelor of Science degree which may be obtained in one year following the completion of the three years' work in Forestry. The additional year allows for the preliminary specialization in some field closely allied to forestry, such as recreational use, soil conservation, game management, forest entomology, forest pathology, etc. A specialized four-year curriculum in range management, leading to the degree of Bachelor of Science in Agriculture is also offered. Nearby forests, logging operations, sawmills and wood using and converting plants are easily reached from the campus. The college operated Clarke-McNary forest tree nursery and the Soil Conservation forest tree, forage crop and range grass nurseries are open to the students.

* *Washington, University of, College of Forestry, Seattle, Washington.*

Undergraduate and graduate courses. The four-year undergraduate course leads to the degree of Bachelor of Science in Forestry and offers

opportunity for specialization in general forestry, logging engineering, forest sciences, and the various phases of forest products including by-products and commercial lumbering. Sophomore students are required to attend a spring or summer quarter of eleven weeks at the 2,000 acre Charles Lathrop Pack Demonstration Forest at La Grande, Washington, on the Rainier National Park Highway. Seniors in forest management and logging engineering spend the last quarter in forests and logging operations easily reached from Seattle. Brief courses in recreation, wildlife management, and range management are offered to undergraduates chiefly to round out their training in general forestry. For specialization in these fields graduate work is recommended. The five-year graduate courses offer opportunity for thorough specialization in technical forestry and in any of the fields that require a broad basic training in forestry. The degrees offered are Master of Forestry (concentrating on technical forestry subjects) and Master of Science in Forestry (requiring a minor in one of the pure sciences). Students having the necessary background for more advanced work are accepted as candidates for the degree of Doctor of Philosophy. Ample facilities for research work by advanced students are provided.

West Virginia University, The College of Agriculture, Forestry and Home Economics. The Division of Forestry, Morgantown, West Virginia.

The first training in forestry was offered in West Virginia in 1935. A four-year course leading to the degree of Bachelor of Science in Forestry was established in the spring of 1937. A five-year course with a broader foundation in scientific and cultural subjects and leading to the same degree is offered and may be chosen at the option of the student. The forestry curriculum is designed to train men in general forestry for positions with public agencies and private owners of forest lands. At the close of the sophomore year, forestry students spend a period of ten weeks in camp. This period is devoted to field work in land surveying, forest measurements, forest utilization, and silviculture. During the third and fourth years, students obtain practical experience by participating in the work on various tracts managed by the West Virginia Forest Products Association which is affiliated with the Division of Forestry. This work, which is under the supervision of staff members, includes volume and growth estimating, marking trees for cutting, logging, and preparing saw timber, pulpwood, and mine props

for the market. Enrollment in the sophomore, junior and senior classes is strictly limited to twenty students each. Application to these upper classes must be made prior to July 15.

* *Yale University, School of Forestry, New Haven, Connecticut.*

Graduates of collegiate institutions of high standing are admitted as candidates for the degree of Master of Forestry, provided they have had the necessary pre-forestry subjects. Two collegiate years and one summer term of technical courses are required of students who have not had prior forestry training. Men entering from other schools where they have received degrees in forestry must be in residence at least one full collegiate year before receiving the professional degree. A combined course of five years permits a student enrolled in the plant science course of the Sheffield Scientific School to take the first year's work of the School of Forestry during his senior year as an undergraduate and to become a candidate for the M. F. degree the year following. The department of forestry in the Yale Graduate School is open to properly qualified students working for the M. S. or Ph. D. degree. The facilities for instruction and research include the following: (1) A library of about 56,600 volumes in Sage Hall. (2) Eli Whitney Forest, property of the New Haven Water Company, a tract of 22,000 acres, part of which has been managed by the School for nearly 40 years; three school forests in New England aggregating 9,500 acres; and the forests of the Crossett Lumber Company in Arkansas and the Urania Lumber Company in Louisiana, where the spring field work for seniors is conducted. (3) A comprehensive wood collection of more than 38,000 samples with accompanying herbarium material and microscopic sections for systematic study of the timbers of the world. (4) Laboratories for work in soils and wood technology. Qualified students of forestry have available the facilities of various departments of the University, especially botany, zoology, geology, economics and engineering. There are also cooperative arrangements with state and federal agencies located in New Haven. A few fellowships and several scholarships are open to adequately prepared students.

SCHOOLS WITH COURSES IN WILDLIFE (OR GAME) MANAGEMENT

This list has been compiled by the United States Forest Service to aid in answering inquiries regarding schools providing instruction in wildlife management. While every effort has been made to avoid errors, the Forest Service does not vouch for the completeness of the list, its accuracy, or the relative merits of the courses offered. Before a final selection is made by the prospective student, he should obtain more detailed information direct from the schools.

* * * * *

Arizona, University of, College of Agriculture, Tucson, Arizona.

Four-year course leading to a Bachelor of Science degree in Agriculture. This course is taken as a major in animal husbandry, or in botany and range ecology, or in combination with both departments. Courses in wildlife management, animal ecology, ornithology, and mammology are offered, together with such supporting courses as are usually given in zoology and botany. The degree of Master of Science is granted on completion of graduate work in either of the two departments.

California, University of, Department of Forestry, Berkeley, California.

Instead of a separate curriculum in wildlife management, the student follows the regular curriculum in forestry, using the ample time available for electives to take work in economic vertebrate zoology in the Department of Zoology. The student thus gets both the viewpoint of the profession of forestry, and the scientific method of the zoologist.

Colorado State College, Division of Forestry, Fort Collins, Colorado.

Wildlife management may be selected as an option in either the forestry or range management curriculum. Fundamental courses in the

biological sciences are offered as well as specialized courses in game and covert management.

Connecticut State College, Storrs, Connecticut.

Undergraduate and graduate training in the field of wildlife management. Degree of B.S. in Agriculture, major in wildlife management. M.S. in Science in field of wildlife management. The first two years of under-graduate work are general foundation subjects, the last two years are elective under adviser system rounding out the student's training in the field of wildlife management and in the supporting subjects. Field work is conducted on the lands of the Connecticut State College, adjacent private lands and on lands under cooperative management of the State Board of Fisheries and Game.

Cornell University, New York State College of Agriculture, Ithaca, New York.

A four-year course in wildlife conservation and game management leading to the degree of Bachelor of Science. The curriculum is so arranged as to meet the needs of prospective technicians in any one of the following fields: Ornithology, game-bird propagation, game management, economic zoology and animal ecology, or fisheries. Advanced work leading to the degrees of Master of Science and Doctor of Philosophy is open to properly qualified students in the Graduate School of Cornell University. Extensive collections are available for laboratory work, as well as ample library facilities. Several game refuges, bird sanctuaries and wildlife preserves are located conveniently near the University. A special announcement descriptive of the course may be had from Professor A. A. Allen, Fernow Hall, Cornell University, Ithaca, New York.

Iowa State College, Department of Forestry, Ames, Iowa.

Four-year course leading to the degree of Bachelor of Science in Forestry with required and elective courses in zoology and wildlife management. Five-year course with special work in wildlife management and zoology leading to the degree of Bachelor of Science in Forestry and Wildlife Management. Basic training in zoology, botany, and other courses.

Louisiana State University, Department of Forestry, University, La.

Four courses in game management are offered. Master's degrees are

offered in game management, prerequisite being a degree in Forestry. In order to secure the Master's degree in one year, it is necessary that the candidate have background courses in zoology, which would make it possible for him to take the courses described. One year at least is necessary to secure the Master's degree in game work.

Maine University, Department of Forestry, Orono, Maine.

Four-year course leading to the degree of Bachelor of Science in Wildlife Conservation. Graduate work leading to the degree of Master of Science. A six weeks' summer camp course required of all students at the end of the sophomore year and a nine weeks' course in the senior year on areas being operated for game management purposes. Facilities for teaching graduate and undergraduate work in game management are handled in connection with the research projects in cooperation with the Fish and Wildlife Service, State, and American Wildlife Institute. Only well qualified students are accepted for graduate work.

Massachusetts State College, Amherst, Massachusetts.

Offers courses in wildlife management to provide the student with a sound understanding of this field of specialization. These technical courses include both classroom instruction and field problems. This work is closely integrated with a curriculum in basic and applied sciences, including botany, ecology, zoology, physiology, chemistry, physics, geology, entomology, forestry and veterinary science, together with a program of courses in mathematics, English, economics, history and modern languages. A sound foundation is laid for graduate study. The graduate school of the College offers courses in wildlife management and related sciences to qualified students working for a Master of Science degree.

Michigan State College, Department of Forestry, East Lansing, Michigan.

Michigan State College offers three course sequences in wildlife management. The Department of Forestry has a major which students can elect in the junior and senior years covering the subject of forest management for wildlife production. This course is designed to train men who expect to administer rural non-agricultural land areas where wildlife production is the major or one of the major uses of the property. The courses include a survey of the entire field of forestry with special

courses in zoology, plant materials and wildlife management. The Zoology Department of the college offers two conservation series; one the wild animal conservation, the other the wild animal propagation. The former course in addition to zoology includes a course in civil engineering, bacteriology and parasitology. The second series of courses include poultry husbandry, bacteriology, and parasitology, in addition to zoology.

Michigan, University of, School of Forestry and Conservation, Ann Arbor, Michigan.

Thorough-going instruction in wildlife management is offered as one of optional programs of study under the forest production curriculum. The work includes a thorough foundation in such basic subjects as zoology, botany, dendrology, forest protection, silviculture, and forest management, with ample opportunity for the election of specific courses dealing with the ecology and management of wildlife. Adequate preparation is impracticable in less than five years, which may lead to the degree of Master of Forestry in the School of Forestry and Conservation, or to the degree of Master of Science in the Graduate School; and a longer time may be required for those with inadequate preparation in biology or forestry. Those planning to specialize in teaching or research should look forward to the doctorate, to which special attention is given at the University.

Minnesota, University of, College of Agriculture, Division of Forestry, University Farm, St. Paul, Minnesota.

Five-year course leading to the professional degree of Master of Forestry and offering three lines of specialization: Technical forestry, range management, and game management. The Bachelor of Science degree is granted on completing the first four years of these five-year curricula, but this degree is not a professional forestry degree. Four-year non-professional curricula in commercial lumbering and wood technology are also available. Students enrolled in any of the professional curricula spend the fourth quarter of the freshman year in the field at the Lake Itasca Forest Biology Station and the third quarter of the senior year at the Cloquet Forest Experiment Station. Graduate courses leading to the degree of Master of Science and Doctor of Philosophy are open to properly qualified students, to whom the research facilities at the Itasca and Cloquet Stations are available.

Montana, University of, Forest School, Missoula, Montana.

Four- and five-year courses allowing specialization in wildlife technology are offered in cooperation with the Division of Biology. The student has the choice of two curricula: (1) A major in forestry with a minor in wildlife technology, leading to the degree of Bachelor of Science in Forestry. (2) A major in wildlife technology with a minor in forestry, leading to a degree of Bachelor of Arts in Wildlife Technology. The degree of Master of Science in Forestry is granted following the satisfactory completion of the requirements for graduate work for those satisfactorily completing the curriculum with a major in general forestry and a minor in wildlife technology. Registration is rigidly limited. Prospective students should submit transcripts of previous high school and college records for evaluation and approval.

Nebraska, University of, College of Agriculture, Departments of Agronomy and Botany, Lincoln, Nebraska.

A new group of conservation courses includes a course in game management which takes up the theory and practice, history, and mechanism, and game environment.

New York State College of Forestry at Syracuse University, Syracuse, New York.

No separate curriculum for a four-year course in wildlife and game management. However, students carrying the regular curriculum may major in forest zoology. The following courses are available for those especially interested in the above mentioned field of work: General zoology, principles of wildlife conservation, invertebrate zoology, vertebrate zoology, comparative anatomy of the vertebrates, animal ecology, parasites and diseases of wildlife, taxonomy of the vertebrates, life histories and habits of the vertebrates, management of forest wildlife, problems in forest zoology, forest zoology seminar, research in forest zoology.

Oregon State College, Corvallis, Oregon.

A four-year curriculum in wildlife management involving economic mammals, birds, and fishes is offered in the Animal Industries Division of the School of Agriculture. The program of studies is composed of agricultural and forestry subjects having direct and practical application in wildlife management in relation to the proper usage of farm, range, and forestry lands, together with basic background subjects in general college work, zoology, botany, chemistry, veterinary medicine and spe-

cialized courses in wildlife management. Particular emphasis is given to the concept that the esthetic, recreational and economic wildlife resources are crops to be produced in harmony with the major uses of land and water. Specialized instruction is offered in commercial fisheries and in fur farming for students desiring educational training in preparation for private enterprises in these fields. Service courses and minor graduate studies in wildlife management are given for students majoring in forestry and range management. A limited number of graduate students are selected each year on the basis of their aptitudes, educational training, and experiences to undertake wildlife management studies of particular value to the United States Fish and Wildlife Service, the United States Forest Service, the Oregon State Game Commission, the Oregon Fish Commission, and the Oregon Wildlife Research Unit. Some of the facilities of these agencies are utilized for instructional purposes.

Pennsylvania State College, Department of Forestry, State College, Pa.

Course in game management. Junior students may elect one of several options, among which is game management. In addition to the required professional forestry courses, these students may secure, by electives and substitutions, seven courses in this special field.

Purdue University, School of Agriculture, Department of Forestry, Lafayette, Indiana.

Special courses in wildlife management offered in the forestry course.

Texas A. and M. College, Department of Fish and Game, College Station, Texas.

Courses in Wildlife Conservation and Management are offered with opportunity for the student to specialize in one of several fields, such as: Parasites and diseases of game and fish, game conservation and management, soil conservation and wildlife, museum procedure, food habits, parks and recreation, refuge management, extension and wildlife research. Background courses in botany, zoology, forestry, agronomy, and general college work are followed by specialized courses in wildlife resources of the United States with special reference to Texas; the structure, distribution, classification, economic relations, ecology, and collection and preparation of study skins of mammals and birds; the foundation for wildlife management on the farm, in the forest, or on the range, also

for museum work; animal-plant interrelationships; the collection, identification, life histories, ecology, conservation and management of fishes; pond and stream improvement; wildlife photography. In all phases of the program, field work is emphasized. Field methods courses are also provided in summer sessions and courses are offered for graduates in advanced wildlife studies and research on wildlife problems. Degrees: Bachelor of Science, Master of Science and Doctor of Philosophy.

Utah State Agricultural College, School of Forestry, Logan, Utah.

Undergraduate and graduate training. The four-year undergraduate course leads to the degree of Bachelor of Science in Forestry. A fifth year of training leading to the degree of Master of Science is offered. A limited number of assistantships are available to graduate students in wildlife management. Emphasis is placed on correlation of wildlife management in relation to forestry and range management. Opportunity for exceptional field work is provided, by the location of the school. A forestry summer term of ten weeks is required. One of the ten regional wildlife research stations under the direction of the Fish and Wildlife Service is established at Logan in cooperation with the Utah Fish and Game Department, and the Forestry School. Federal and State agencies with active projects in or near Logan which afford unlimited opportunity for field experience are the Forest Service and experiment stations, Grazing Service, Bureau of Animal Industry, Soil Conservation Service, State Fish and Game Department, Fish and Wildlife Service, and Wildlife Experiment Station.

Virginia Polytechnic Institute, Department of Biology, Blacksburg, Virginia.

A four-year curriculum in conservation and forestry leads to the B.S. degree. Emphasis is placed on wildlife conservation and management. Graduates who wish to become professional foresters are expected to take postgraduate work in a school of forestry. Those who expect to make some form of wildlife work their career are prepared to enter this field or they may secure more advanced training in postgraduate study in the department. This college is one of several in the United States which is cooperating with the Fish and Wildlife Service and the State Commission of Game and Inland Fisheries in a research and educational program. This provides exceptional opportunity for students who wish to receive practical as well as scientific training in wildlife conserva-

tion. The department has for its use large tracts of forest mountain land which provide facilities for education and research.

Washington, State College of, Department of Zoology, Pullman, Washington.

The Zoology Department offers a full four-year professional course leading to the degree of Bachelor of Science in Wildlife Management. Graduate work is also given leading to a Master's degree. The courses are not limited to students specializing in wildlife management but are open to forestry and range management students as well as others having the proper prerequisite training.

The study of basic zoology is required before entering upon courses in ornithology, mammalogy, aquatic zoology, and natural history, these being basic to the wildlife courses. Substantial amounts of botany, forestry and range management are required and students are advised to take additional courses in these fields. A principles course in wildlife conservation is given for students in other fields who desire a general knowledge of wildlife conservation. Wildlife ecology is given as a special course, prerequisite to management courses which deal with the principles of management technology. The advanced courses, offered only to seniors and graduate students, cover the practical problems of management.

Wisconsin, University of, Division of Wildlife Management, Madison, Wisconsin.

Graduate study for not to exceed five selected students, who work jointly with the Division of Wildlife Management and the departments concerned with their research. Degree: Master of Science or Doctor of Philosophy. Facilities: University Arboretum and five groups of experimental farms.

Yale University, School of Forestry, New Haven, Connecticut.

Wildlife management is offered as a feature of forest management and other basic courses. A separate course is not given in this field, but graduate work is provided for in cooperation with the Department of Zoology and Peabody Museum. The Frank Richard Oastler collection of 5,500 lantern slides and 200 reels of motion pictures of wildlife is available for study.

SCHOOLS WITH COURSES IN RANGE MANAGEMENT

Compiled by the United States Forest Service to aid in answering inquiries regarding instruction in range management. While every effort has been made to avoid errors, the Forest Service does not vouch for the completeness of the list, its accuracy, or the relative merits of the courses offered. Before a final selection is made by the prospective student, he should obtain more detailed information direct from the schools.

It is important that men trained for Forest Service range management work should have, if possible, courses in plant physiology, systematic botany, plant ecology, animal husbandry such as feeding and breeding of livestock, surveying, economics, zoology, and especially the underlying principles of subjects of forestry and range management, including the application of the basic principles of botany, animal husbandry, silviculture, general conservation, improvement, and use of the forest resources as a whole.

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Arizona, University of, College of Agriculture, Tucson, Arizona.

Four-year course leading to a Bachelor of Science degree in Agriculture. This course is taken as a major in animal husbandry or in botany and range ecology, or in combination with both departments. There is considerable flexibility in electing supporting courses in surveying, soils, geology, and other courses needed. The degree of Master of Science is granted on completion of graduate work in either of the two departments.

California, University of, Department of Forestry, Berkeley, California.

Four-year course in range management leading to the degree of Bachelor of Science. This course gives a comprehensive training in range

management and forestry, and basic training in botany, surveying, and allied subjects. The degree of Master of Science is granted on completion of one year of satisfactory graduate work. The degree of Doctor of Philosophy is available to students of range management through work in the underlying sciences.

Chicago, University of, Department of Botany, Chicago, Illinois.

Degrees of Bachelor of Science, Master of Science, or Doctor of Philosophy, with major in botany, are granted on the completion of the necessary work. Excellent opportunity is afforded to secure a thorough and fundamental background for the prosecution of research or teaching in the whole field of pure and applied botany. Among the courses which should appeal strongly to students of forestry, range management, or agriculture are: systematic botany, elementary physiographic ecology, experimental ecology, forest ecology, ecology of grasslands and deserts, ecology of arable lands, methods in ecology, and plant nutrition.

Colorado State College, Division of Forestry, Fort Collins, Colorado.

Range management is a distinct curriculum given by the Department of Range and Pasture Management and leads to the degree of Bachelor of Science in Forestry. A comprehensive training in range management courses is offered, and because of a liberal system of electives the individual student may strengthen himself in such allied fields as botany and animal husbandry. A summer camp of ten weeks at the end of the sophomore year is required. Camp enrollment is limited and applications must be in by May 1st.

Georgia, University of, School of Forestry, Athens, Georgia.

Four-year course leading to the degree of Bachelor of Science in Forestry. Considerable latitude for specialization is offered for junior and senior years. Courses in botany, animal husbandry, and surveying are available. A five-year course is also offered leading to the degree of Master of Science in Forestry.

Idaho, University of, School of Forestry, Moscow, Idaho.

Range management is a distinct curriculum in the School of Forestry leading to the degree of Bachelor of Science in Forestry. This curriculum offers a comprehensive training in forestry, botany, and a very basic training in range management and animal husbandry as related to the technical problem of the range. Courses in game and wildlife manage-

ment and conservation measures, with particular emphasis on erosion, add a strong minor field of study to range management. Graduate work in a selected field may be followed in a fifth year, leading to the degree of Master of Science in Forestry. Following the sophomore year, a ten weeks' summer camp is required of all students. Library, laboratory, nursery, experimental forest, private, state and national forest areas are adequate for extensive field work.

Illinois, University of, Department of Botany, Urbana, Illinois.

Thorough botanical training, particularly in graduate study. Courses in forest ecology, plant ecology (with study of grasslands) systematic botany, and plant physiology. Cooperative relations with Department of Agronomy (including soil science) and State Natural History Survey. Cooperative reforestation between Illinois (in charge of Natural History Survey) and United States Government now is being carried on. In other departments, work in surveying, animal husbandry, and basic sciences. Four-year course (major in botany) with degree of Bachelor of Arts; Master of Science with one year of graduate study including thesis; Doctor of Philosophy after minimum study period of three years.

Iowa State College, Department of Forestry, Ames, Iowa.

Four-year course leading to the degree of Bachelor of Science in Forestry, with elective courses in range management. Five-year course with special work in range management and botany leading to the degree of Bachelor of Science in Forestry and Range Management. Additional graduate work leading to the degree of Master of Science in Forestry or Range Management. Basic training in botany, zoology, animal husbandry, and other courses.

Kansas State College, Manhattan, Kansas.

Four-year course leading to a degree of Bachelor of Science in Agriculture. This course can be arranged to give a comprehensive training in range management, animal husbandry, and botany, with general training also in surveying and forestry. Special courses related to the field of range management include Pasture Improvement I and II; Farm Forestry; Forest Nursery Practice; Silviculture; Nature and Development of Plants; Medical Botany; Taxonomic Botany of Flowering Plants; Botanical Microtechnic; Field Botany; Plant Ecology; Anatomy of the Higher Plants; and research problems in botany and pasture management, available to a limited number of students.

Michigan State College, Department of Forestry, East Lansing, Michigan.

A four-year course leading to the degree of Bachelor of Science in Forestry with graduate courses leading to the degree of Master of Science. A general course in range management is given in the Department of Forestry supplemented by other required forestry courses and elective courses in botany, soils, and animal husbandry.

Michigan, University of, School of Forestry and Conservation, Ann Arbor, Michigan.

Four- and five-year programs leading to the degree of Bachelor of Science in Forestry and Master of Forestry, respectively. These programs give a comprehensive training in forestry and the underlying biological and social sciences. A special course is offered in range management, with ample opportunity for problem work in this field, and in close correlation with courses in ecology and wildlife management.

Minnesota, University of, College of Agriculture, Division of Forestry, University Farm, St. Paul, Minnesota.

Five-year course leading to the professional degree of Master of Forestry, and offering three lines of specialization: Technical forestry, range management, and game management. The Bachelor of Science degree is granted on completing the first four years of these five-year curricula, but this degree is not a professional forestry degree. Four-year non-professional curricula in commercial lumbering and wood technology are also available. Students enrolled in any of the professional curricula spend the fourth quarter of the freshman year in the field at the Lake Itasca Forest Biology Station and the third quarter of the senior year at the Cloquet Forest Experiment Station. Graduate courses leading to the degree of Master of Science and Doctor of Philosophy are open to properly qualified students, to whom the research facilities at the Itasca and Cloquet Stations are available.

Montana, University of, Forest School, Missoula, Montana.

Four- or five-year course leading to the degree of Bachelor of Science in Forestry with specialization in range management. The degree of Master of Science in Forestry is granted on satisfactory completion of the requirements for graduate work. Registration is rigidly limited. Prospective students should submit transcripts of their previous high school or college records for evaluation and approval.

Nebraska, University of, College of Agriculture, Departments of Agronomy and Botany, Lincoln, Nebraska.

A new group of conservation courses related to range management is offered by the Department of Agronomy. These include elementary study of grasses and legumes and the various cultural practices, followed by a study of range areas of the United States and specialized studies of grasses and legumes and other forage plants with relation to their environment and carrying capacities. The Department of Agronomy includes in its requirements plant ecology and a complete set of courses in soils.

Nevada, University of, College of Agriculture, Reno, Nevada.

Four-year course leading to the degree of Bachelor of Science in Agriculture. This course gives training in botany, animal husbandry, surveying, and a general course in forestry. A Master's degree is given upon the completion of a year's graduate work with thesis in any one of the above special fields. In addition to the general course in agriculture, a new course has been inaugurated in forestry and range management leading to the Bachelor of Science degree. This course is especially provided to prepare young men for work in forestry and range management.

New Mexico State College of Agriculture and Mechanic Arts, State College, New Mexico.

Four-year curricula leading to the Bachelor of Science degree in Agriculture. In addition to basic courses in Botany, Zoology, Soils, Animal Husbandry and Economics, students prepared for range management work take such courses as Range Beef Production, Range Sheep and Wool Production, Systematic Botany, Plant Physiology, Plant Ecology, Agrostology, and Land Economics.

North Dakota Agricultural College, Fargo, North Dakota.

Courses of collegiate grade are offered in the Department of Botany. Those applying to range management are as follows: Range and pasture management and improvement, methods and principles of range and pasture management, maintenance and improvements of grassland productivity, evaluation of range lands, and characteristics of important forage and poisonous plants. A correspondence course in range management is conducted, which takes up a review of botany, particularly systematic botany, plant physiology and ecology, and the principles of

range management, and considers forest growth, erosion control, and game management. Some time is devoted to the study of new methods of research work in range ecology.

Oklahoma A. & M. College, Stillwater, Oklahoma.

Four-year course leading to the degree of Bachelor of Science in Agriculture which gives comprehensive training in the fields of agronomy, botany, and animal husbandry. Two years of comprehensive work leading to a degree are furnished to those who plan to major in forestry. They include such courses as branches of engineering, botany, biology, wildlife conservation, game management and fish culture, zoology, and ecology. However, there is no four-year course leading to a degree in either range management or game management.

Oregon State College, Corvallis, Oregon.

Four-year courses are offered leading to the degree of Bachelor of Science in Forestry in the School of Forestry, and in Agriculture in the School of Agriculture. These courses can be arranged to give a comprehensive training in forestry, botany, animal husbandry (especially from the standpoint of range management) and also with basic training in surveying. These curricula integrate with the courses offered in game management. The student therefore has an opportunity to round out his training in the related field of wild life conservation and management. The training offered qualifies men for positions with agencies having the responsibility of administering public lands, both Federally and state owned, and for range management on privately owned lands. A degree of Master of Science is granted on completion of one year of graduate work.

Pennsylvania State College, Department of Forestry, State College, Pa.

Four-year course in forestry which gives, in addition to a comprehensive forestry training, basic training in botany, animal husbandry, surveying, and other fundamental subjects including a special course in range management.

Utah State Agricultural College, School of Forestry, Logan, Utah.

Four-year courses are offered in forestry, range management, soil conservation, and wildlife management, upon completion of which the degree of Bachelor of Science is granted. A fifth year of training leading

to the degree of Master of Science is offered in range management. A limited number of assistantships are available to graduate students in this field. Courses are designed to give an accurate picture of land use problems in the western states with special attention being given to the administration and technical problems of timber, recreation, range forage, soil and game management. Federal and State agencies with active projects in or near Logan which afford unlimited opportunity for field experience are the Forest Service and experiment stations, Grazing Service, Bureau of Animal Industry, Soil Conservation Service, State Fish and Game Department, Fish and Wildlife Service, and Wildlife Experiment Station. Further field experience is obtained in a required ten-week summer camp carrying regular college credit, and in organized field trips through Utah and adjacent states. Note: All the courses suggested in the preface are included in the curriculum.

Washington, State College of, Department of Forestry and Range Management, Pullman, Washington.

A specialized four-year course is offered in range management leading to a Degree of Bachelor of Science in Agriculture. The range management curriculum is intended to fit range technicians for any one of three phases of work, for example: (1) With the Federal Government in the grazing branch of the U. S. Forest Service, the Grazing Service of the U. S. Department of Interior, the Indian Service, and the Soil Conservation Service, (2) with individuals, companies, or corporations owning large areas of land suitable for grazing, (3) the occupation of raising livestock under open range conditions, either as owners or as managers of ranch and range property. This four-year course in range management includes such essentials as botany, animal husbandry, range management, zoology, surveying, etc. The Regional range, grass and forage crop nursery operated by the Soil Conservation Service is available for study.

Wyoming, University of, College of Agriculture and Department of Botany, Laramie, Wyoming.

Four-year course leading to a Bachelor of Science degree in Agriculture, with a major in animal husbandry and also in botany. This course offers basic training in agronomy, animal husbandry, botany, range management, surveying and allied subjects. Special courses in ecology and range ecology are given on the campus and at the Science Summer

Camp located in the Medicine Bow National Forest. The degree of Master of Science is granted on the completion of the necessary graduate work.

Yale University, School of Forestry, New Haven, Connecticut.

Range management is offered as a feature of forest management and other basic courses. Separate course is not given in this field.

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